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MODELING OF THE NON-AUDITORY RESPONSE TO BLAST OVERPRESSURE

Summary of Blast Overpressure Field Data

ANNUAL/FINAL REPORT

W. Roush
M. J. Vander Vorst
J. H. Stuhmiller
J. Morris

JANUARY 1990

Supported by

U.S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21701-5012

Contract No. DAMD17-85-C-5238

JAYCOR
11011 Torreyana Road
San Diego, California 92121-1190

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report is a compilation of blast overpressure field data taken at the Blast Overpressure Test Site in Albuquerque, New Mexico. The work was conducted under the direction of Dr. D. R. Richmond and a complete list of source documents is contained in the Reference section. Most of the field tests involved sheep placed in the blast environment. The purpose was to empirically correlate injury to blast wave parameters. This report summarizes the test data compiled to date, but is by no means all inclusive. Corresponding to each test are plots of the associated incident pressure field.

The purpose of this report is to provide a convenient summary of these tests for use by all researchers.

This report is organized into seven sections, each devoted to a different blast study. They are: Armored Personal Carrier (APC); Bunker Summer Studies of 85, 86, 87; Double Peak; and Iso-Impulse. Within each section, a separate page describes each combination of charge type, charge weight, height of burst, and range.

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Summary of Blast Overpressure Field Data

19. ABSTRACT *(Continued from front)*

section there are different configurations in which the blast environments are functions of charge type, charge weight, height of burst, and range. Before expanding on the different blast studies, a description of the summary sheet is in order.

SUMMARY OF BLAST OVERPRESSURE FIELD DATA

W. Roush
M. J. Vander Vorst
J. H. Stuhmiller
J. Morris
Applied Science and Engineering Technology
JAYCOR

ABSTRACT

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CONTENTS

INTRODUCTION

This report is a compilation of blast overpressure field data taken at the Blast Overpressure Test Site in Albuquerque, New Mexico. The work was conducted under the direction of Dr. D. R. Richmond and a complete list of source documents is contained in the Reference section. Most of the field tests involved sheep placed in the blast environment. The purpose was to empirically correlate injury to blast wave parameters. This report summarizes the test data compiled to date, but is by no means all inclusive. Corresponding to each test are plots of the associated incident pressure field.

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SUMMARY SHEET DESCRIPTION

The summary sheet is broken down into five areas.

The first area is Blast Conditions, which defines the physical configuration of the test. Geometry defines the location of the test, such as in the open free field or inside an enclosure. H.O.B. is the height of burst and Distance is the horizontal distance along the ground from the charge to the sensor. The Charge weight of the explosive and the charge type are also given.

The second area is Blast Parameters, which summarizes features of the pressure signal. This data includes the maximum incident pressure. The positive duration (t_a) is the time interval between the initial pressure rise and the first return to ambient pressure. The positive impulse is defined by

$$I(a) = \int_0^{t_a} p(t) * dt \qquad (1)$$

while the total duration is defined by

$$I_t = \int_0^{t_t} p(t) * dt \qquad (2)$$

where t_t is the total time of the recorded signal.

The third area is Shot which lists all of the data collected under these test conditions and whether the shots were repeated. An identification number and lung injury grade are given for each animal exposed. The grades are defined as follows:

N = no injury

TH = threshold or slight

M = moderate

E = extreme

The time and date of the shot is given along with the number of the references from which the data was obtained.

The fourth area is the Data Collected which is a table listing the types of pressures measured for the particular shots as defined below.

Ps = incident pressure

skin = skin gauge data

Lamb = Lambdroid data which is load, incident, and backside

Esoph = esophageal gauge data

Plral = pleural surface gauge data

Adom = abdominal gauge data

Vic = Victor

The fifth area is References. The references are the sources for the information in the first four areas.

BLAST STUDIES

This report will not dwell into the aspects of the blast studies. If specific information is needed one should seek out the reference given. This section will explain the variations in the summary sheets of the different studies.

APC

The APC study was conducted with two different blast geometries: in the free field and inside an Armored Personnel Carrier. The free field geometry produces a Friedlander [1] type wave. For these cases, no field pressure traces were reported so the corresponding plots were generated by the COMPLX [2] computer model. The APC geometry used an explosive detonated inside an APC, producing a complex blast environment [2]. The value of the total impulse has been computed for a time interval of 20 ms, shown in parentheses on the summary sheets. The plots represent averaged data. The values in parentheses for maximum pressure, positive duration, and positive impulse were retrieved from an unaveraged database, while those not in parentheses are the values from the averaged data.

BUNKER

In all the bunker tests, explosives were detonated inside an 8' × 8' × 10' enclosure, producing complex blast waves. As with the APC, the values are quoted for both averaged and unaveraged data.

SUMMER STUDIES 85, 86, 87

The purpose of the Summer Study 85 test was to expose animals to multiple shots. The blast parameters on the summary sheets are of a single blast, while the injury grades correspond to 20 blast exposures. Plots of a same single blast but in addition there is a plot that has overlays of different shots listed on the summary sheets. The purpose of the overlay plots is to see if there is consistency in the pressure field for blasts of the same conditions.

The purpose of the Summer Study 86 tests was to repeat 85, but also to collect more data. Such that in 86 they collected pleural and abdominal pressures, whereas in 85 they didn't. The same is true for the 87 tests plus they want to improve on the data collection ability.

DOUBLE PEAK

The purpose of the double peak study was to detonate two explosives at different time intervals. There were two stations for collecting data, which were of the same range from the blast, north and south or east and west depending on the test. There is such a discrepancy in the data between the two stations that both sets of information have been included.

ISO-IMPULSE

The purpose of the iso-impulse was to test the theory that blasts with different conditions but the same incident peak pressure and impulse, would cause the same injuries. The authors have no data from the tests, so, using COMPLX [2] they generated some blast conditions that gave the same incident peak pressure and impulse as given in the Iso-Impulse report.

SUMMARY

These seven studies were not necessarily the only ones conducted but they are the tests that the authors have knowledge of and references to. Thus this report is intended to grow as more information is obtained. There are many bits of information needed just to complete the summary sheets on the seven blast studies reported here, such as the injuries for Summer Studies 86 and 87.

Within time this report will become a complete document such that any person seeking information on small blasts with corresponding sheep injuries will have the data readily available. This will become very valuable as modeling overtakes empirical field tests for determining blast injuries of today and tomorrow.

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2. Roush, William and James H. Stuhmiller, "Computer Model of Complex Waves Within an Enclosure and Their Biological Effects," JAYCOR Technical Report, August 1989.

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Dodd, K. T., et al., "Analysis of Field Test Results of the Biophysical Response of Sheep to Blast Loading," Department of Respiratory Research, Walter Reed, JAYCOR, and Los Alamos National Laboratories, Kirtland AFB, 1987.

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Richmond, D. R., et al., "Double Peak Study Results Report," ITRI Biodynamics Laboratory, Lovelace Foundation Report, June 18, 1982.

Vander Vorst, M. J. and J. H. Stuhmiller, "Calculation of Parenchymal Pressure Due to Double Peak Loading," JAYCOR Report, February 22, 1987.

Presentation of Iso-Impulse Study (20 blast).

APC

Blast Overpressure Field Data
Case APC57FF
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.057 kgm
Charge type	Pentolite

Blast Parameters:

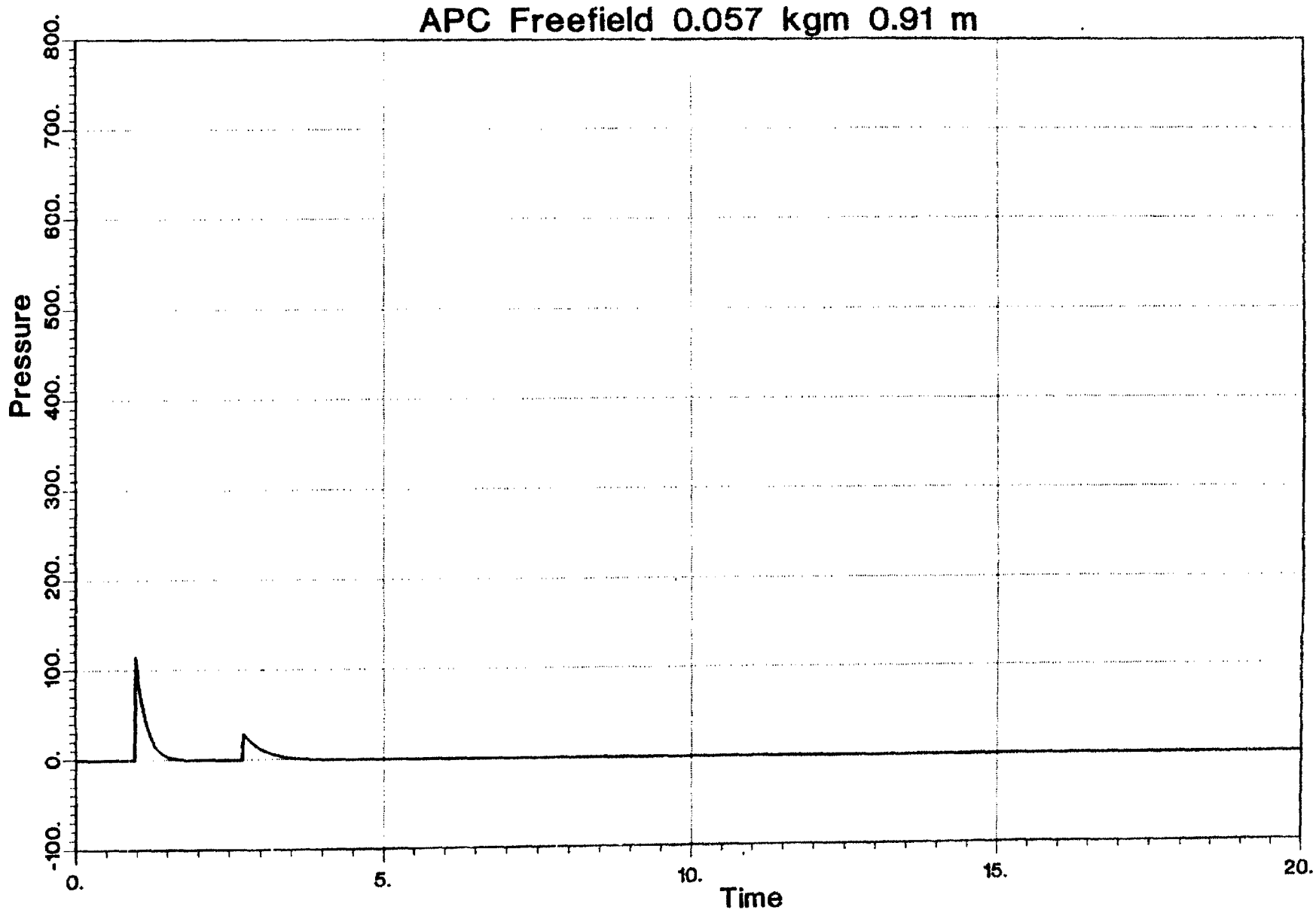
Maximum Pressure	115.1 kPa
Positive duration (Ta)	0.84 ms
Positive Impulse (Ia)	19.3 kPa ms
Total Impulse (It)	28.0 kpa ms (20 ms)

	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							
	N			1							

Reference:

1) Biologic Response to Complex Blast Waves; D.Richmond, J.Yelverton, E.Fletcher, Y.Phillips; September,1985, (Pentolite).

APC57 South
9/01/85 Device 1 Channel 1 Shot 58
1 TNT 1 HOB, 11 Range



Blast Overpressure Field Data
Case APC113FF
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.113 kgm
Charge type	Pentolite and C4

Blast Parameters:

Maximum Pressure	197.6 kpa
Positive duration (Ta)	0.95 ms
Positive Impulse (Ia)	30.6 kpa ms
Total Impulse (It)	43.2 kpa ms (20 ms)

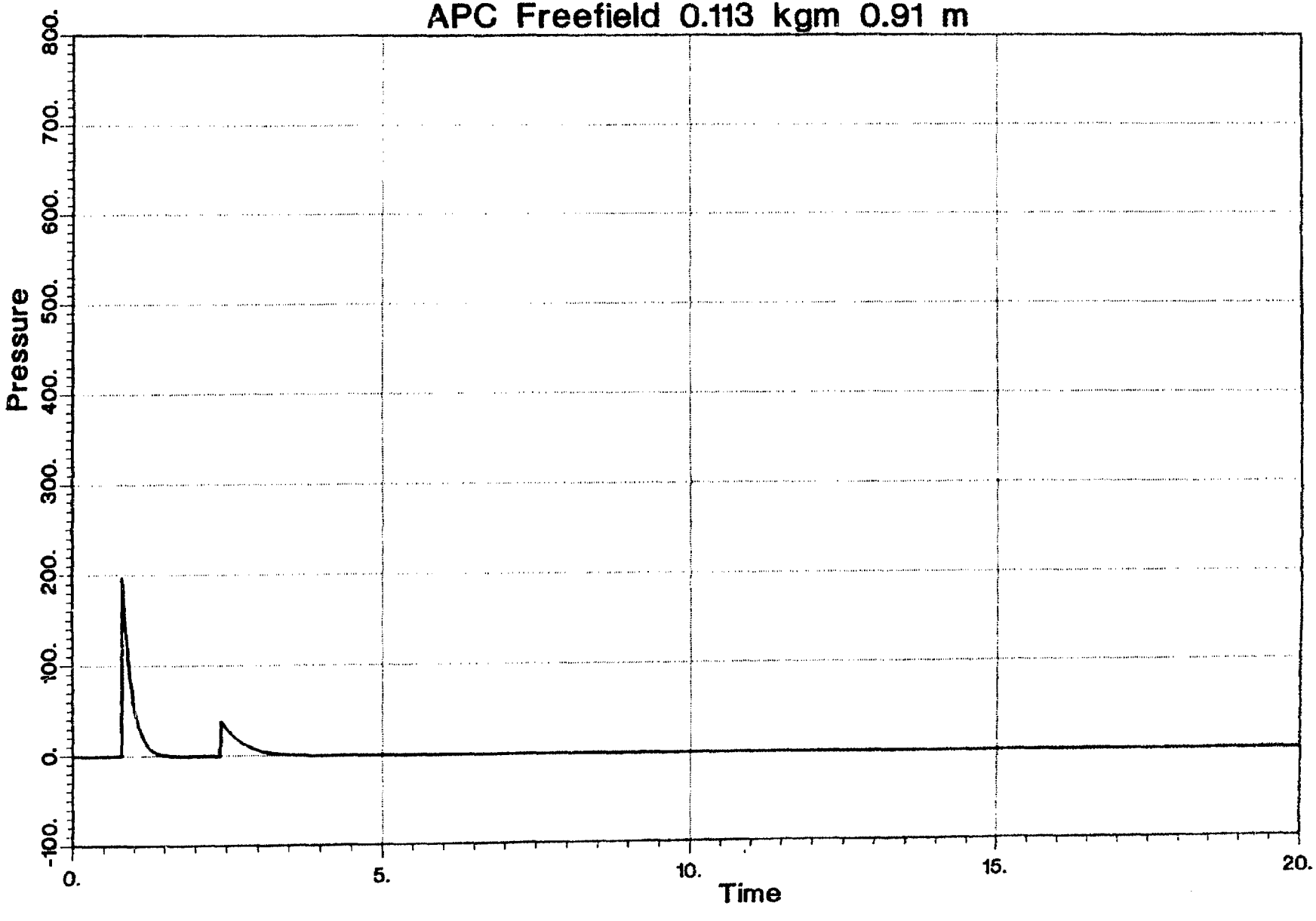
Shot:				Data Collection:	
Animal ID	Injury Grade	Time	Date	Ref #	Ps Skin Lamb Esoph Plral Adom Vic
	N			1	
	N			1	
	N			2	
	N			2	
	N			2	
	N			2	
	N			2	

Reference:

1) Biologic Response to Complex Blast Waves; D.Richmond, J.Yelverton, E.Fletcher, Y.Phillips; September,1985, (Pentolite).

2) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

APC113 South
9/01/85 Device 1 Channel 1 Shot 59
1 PENTO 1 HOB, 11 Range



Blast Overpressure Field Data
Case APC227FF
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

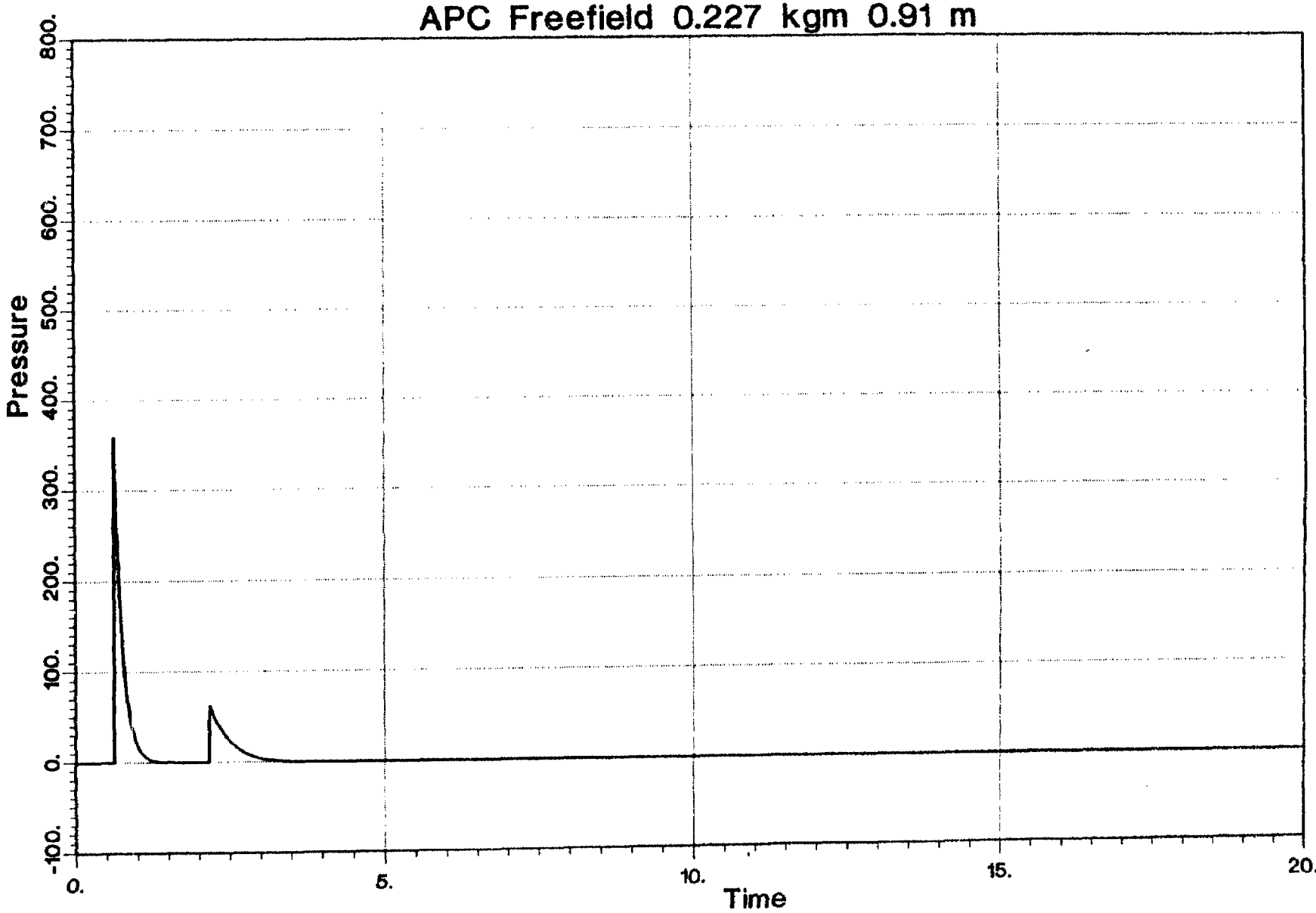
Maximum Pressure	359.5 kPa
Positive duration (Ta)	1.2 ms
Positive Impulse (Ia)	48.0 kPa ms
Total Impulse (It)	68.3 kpa ms (20 ms)

	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	M			1							
	TH			1							
	TH			1							

Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

APC227 South
2/01/87 Device 1 Channel 1 Shot 60
1 PENTO 1 HOB, 11 Range



Blast Overpressure Field Data
Case APC227FF
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.76 m
Distance	0.122 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	165.3 kPa
Positive duration (Ta)	1.2 ms
Positive Impulse (Ia)	35.3 kpa ms
Total Impulse (It)	53.3 kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							
	N			1							
	N			1							
	N			1							
	N			1							

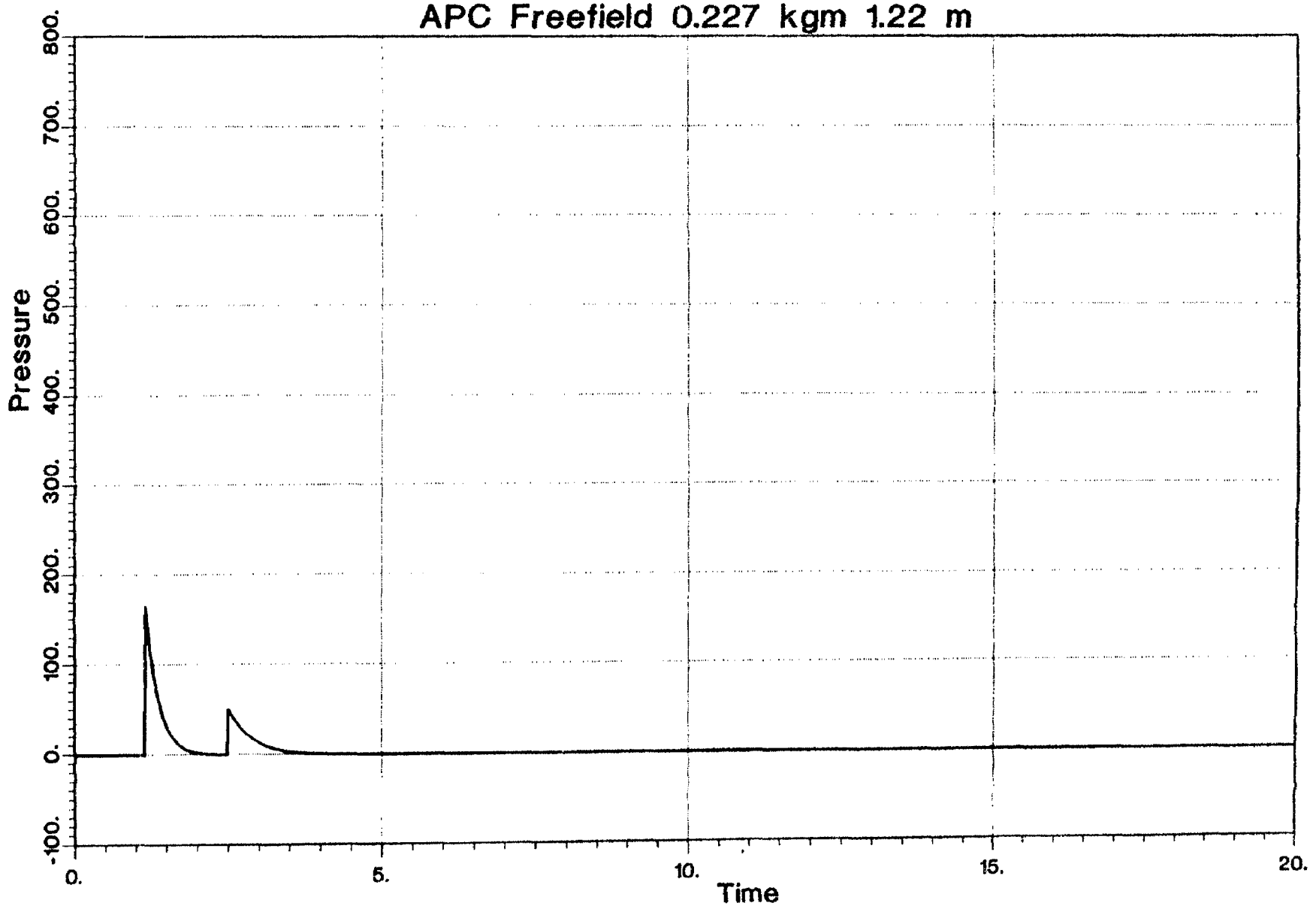
Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

APC27N South

9/01/85 Device 1 Channel 1 Shot 62

1 PENTO 1 HOB, 11 Range



Blast Overpressure Field Data
Case APC454FF
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

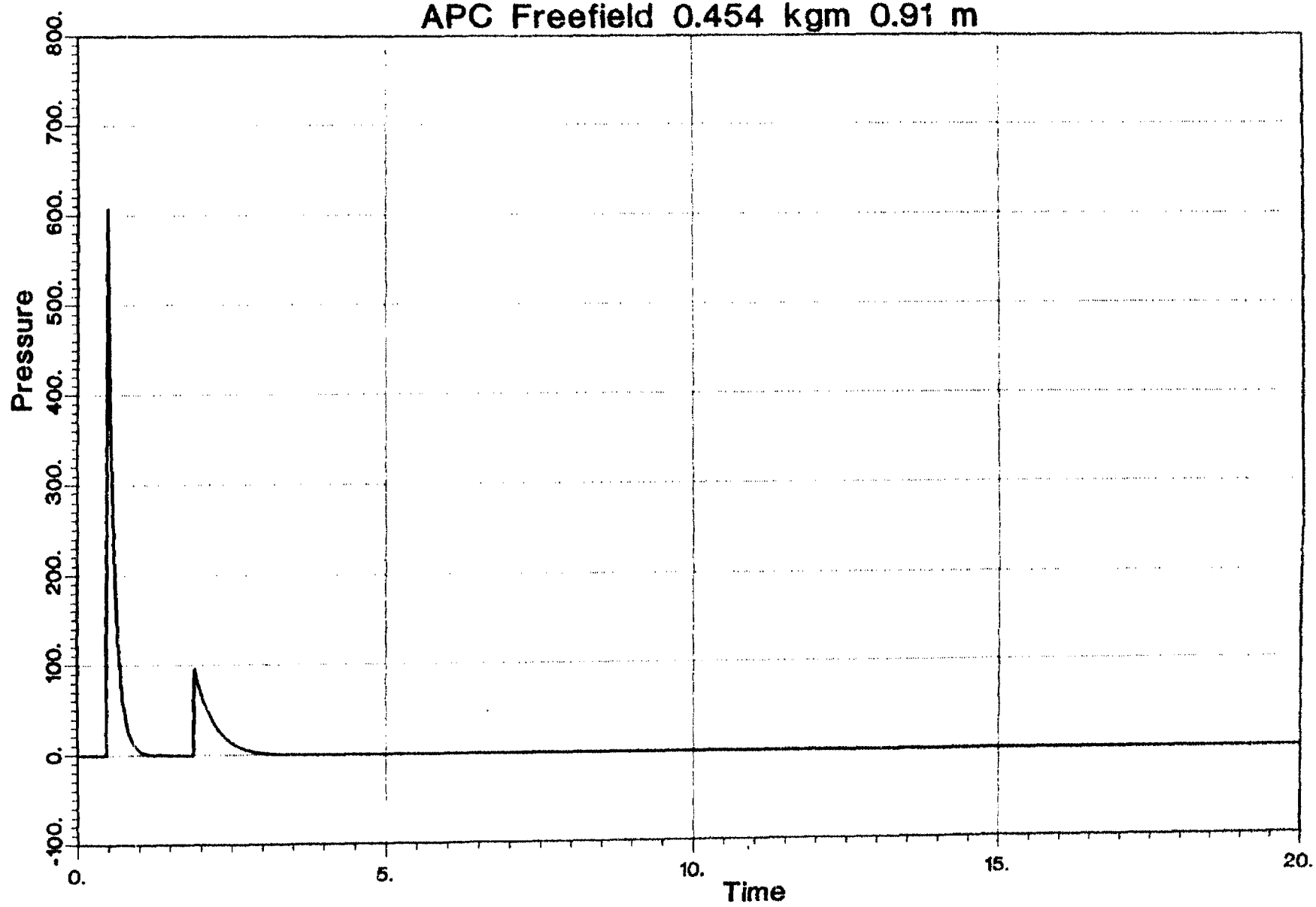
Maximum Pressure	607.9 kPa
Positive duration (Ta)	3.0 ms
Positive Impulse (Ia)	103.2 kPa ms
Total Impulse (It)	103.0 kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	TH			1							
	TH			1							

Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

APC454 South
9/01/85 Device 1 Channel 1 Shot 61
1 PENTO 1 HOB, 11 Range



Blast Overpressure Field Data
Case APC57NF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.57 kgm
Charge type	Pentolite and C4

Blast Parameters:

Maximum Pressure	83.0 (95.0) kPa
Positive duration (Ta)	1.17 (.801) ms
Positive Impulse (Ia)	31.6 (24.0) kPa ms
Total Impulse (It)	264.6 kpa ms (20 ms)

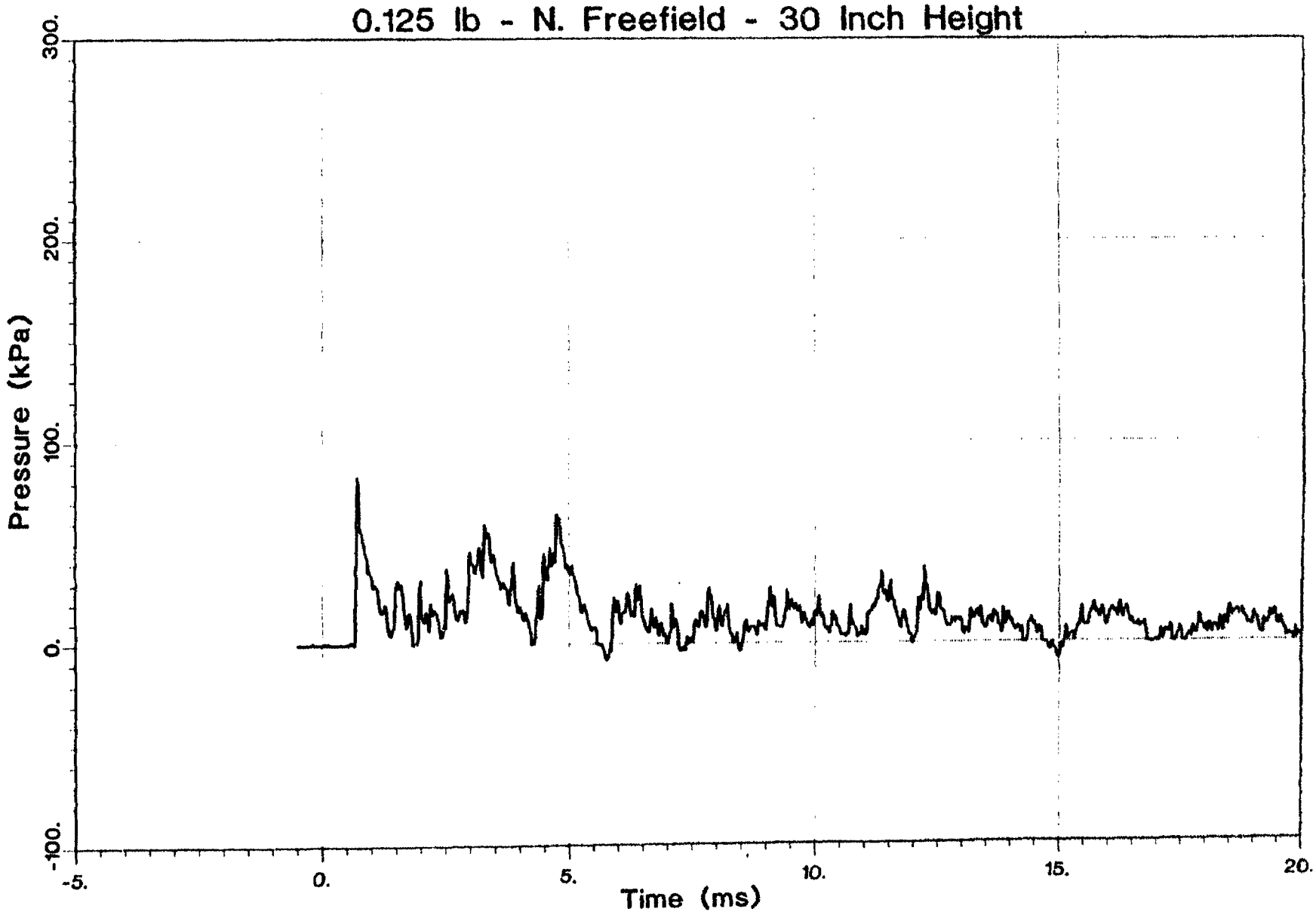
	Shot:				Data Collection:				
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							
	N			1							
	N			1							
	N			1							
none	N	11:17	8/11/86	2	Y		Y				Y
none	N	13:26	8/12/86	2	Y		Y				Y

Reference:

1) Biologic Response to Complex Blast Waves; D.Richmond, J.Yelverton, E.Fletcher, Y.Phillips; September,1985, (Pentolite).

2) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

COMP125N001 30 Inch Height
13:26:21.56 8-12-1986 Device 2 Channel 1 Shot 2
0.125 lbC-4 2.5 ft HOB, 3.0 ft Range



Blast Overpressure Field Data
Case APC57SF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	1.22 m
Charge wt.	0.57 kgm
Charge type	Pentolite and C4

Blast Parameters:

Maximum Pressure	145.6	(163.3) kPa
Positive duration (Ta)	0.74	(0.56) ms
Positive Impulse (Ia)	22.0	(18.5) kPa ms
Total Impulse (It)	300.3	kpa ms (20 ms)

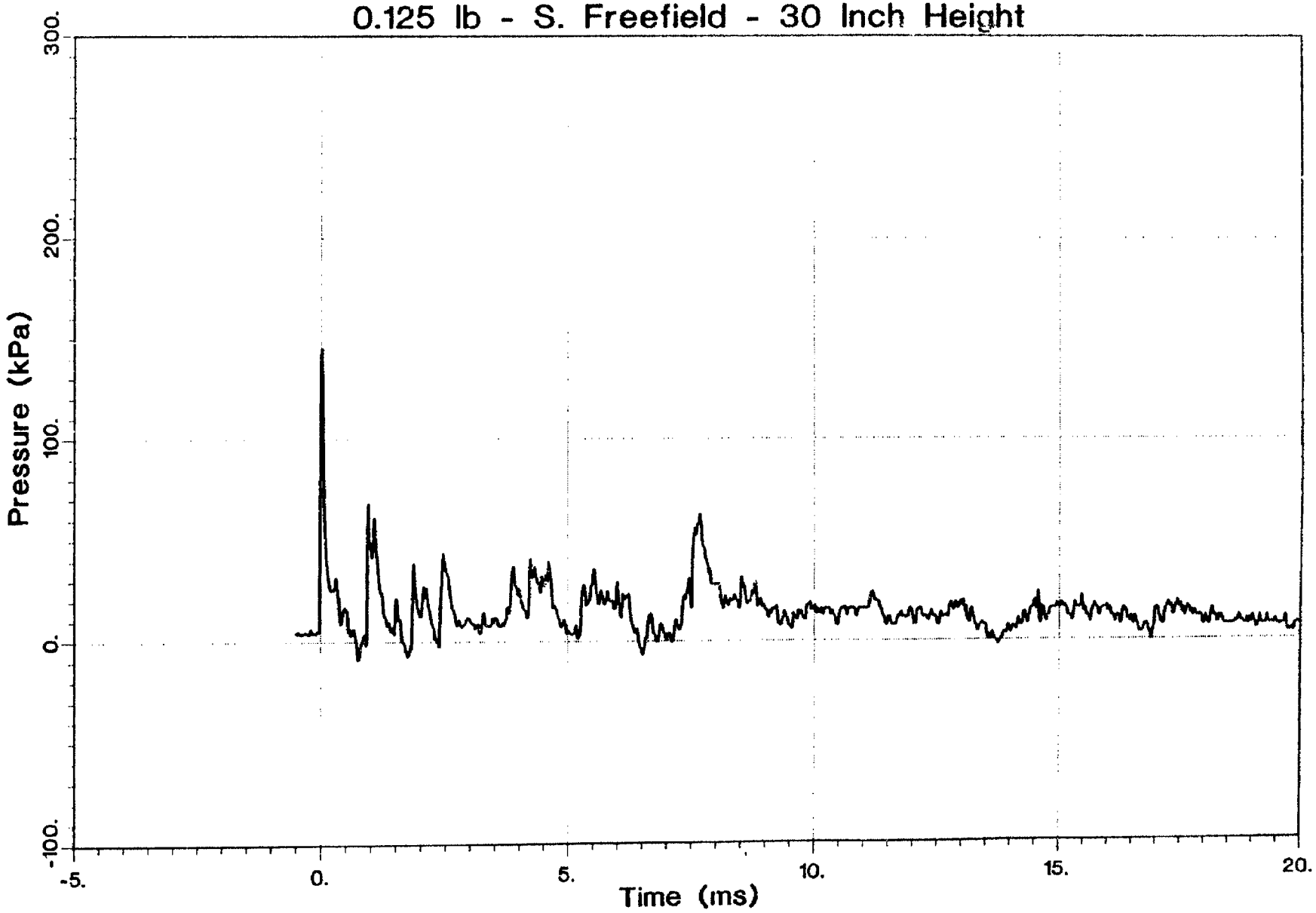
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							
	N			1							
	N			1							
	N			1							
none	N	11:17	8/11/86	2	Y		Y				Y
none	N	13:26	8/12/86	2	Y		Y				Y

Reference:

1) Biologic Response to Complex Blast Waves; D.Richmond, J.Yelverton, E.Fletcher, Y.Phillips; September,1985, (Pentolite).

2) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

COMP125 000 30 Inch Height
11:17:30.57 8-11-1986 Device 2 Channel 2 Shot 1
0.125 lbC-4 2.5 ft HOB, 4.0 ft Range



Blast Overpressure Field Data
Case APC113NF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.113 kgm
Charge type	Pentolite and C4

Blast Parameters:

Maximum Pressure	128.8	(138.5) kPa
Positive duration (Ta)	5.8	(5.76) ms
Positive Impulse (Ia)	225.0	(202.3) kPa ms
Total Impulse (It)	524.7	kpa ms (20 ms)

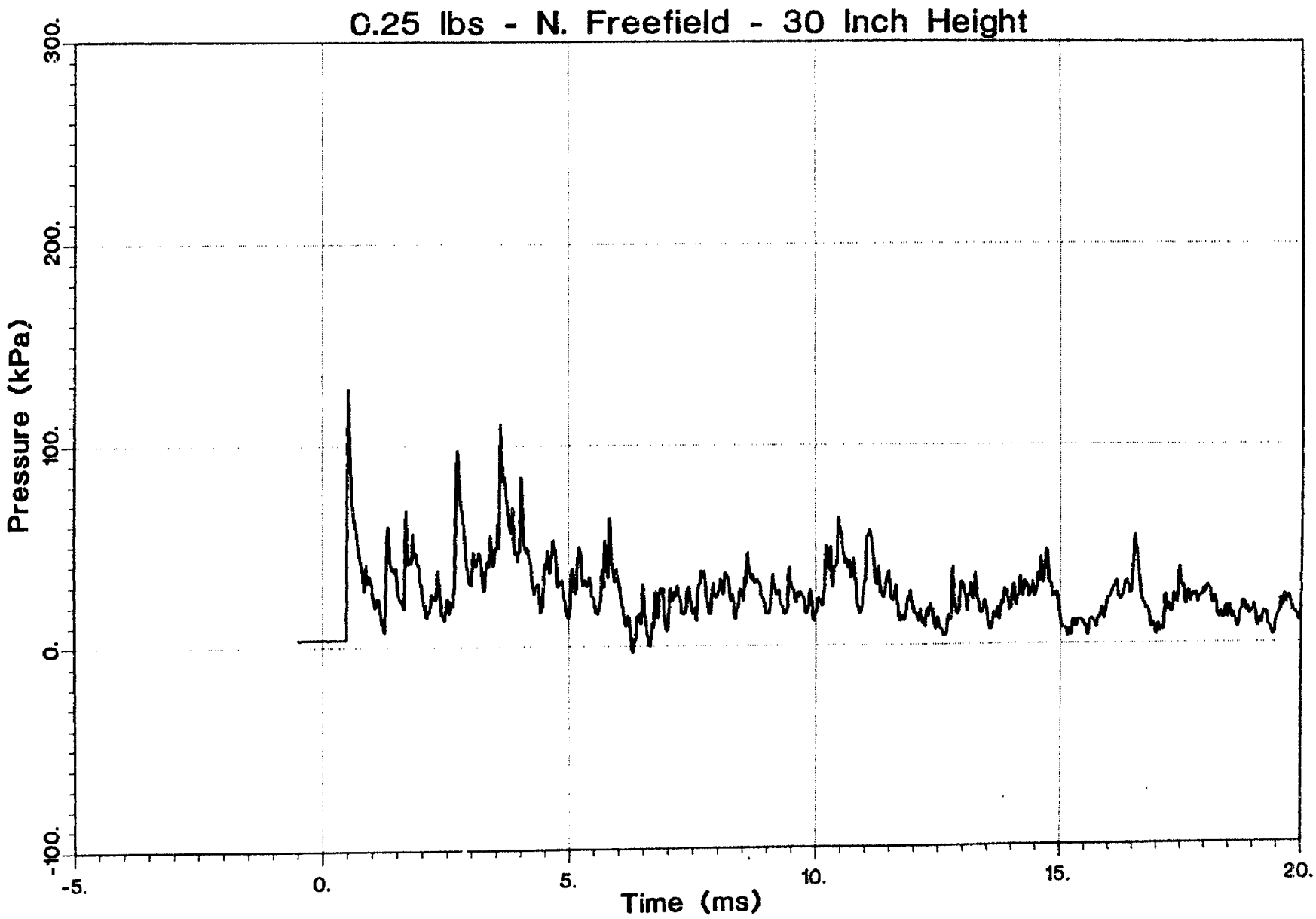
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							
	N			1							
	N			1							
	N			1							
none	N	14:00	8/11/86	2	Y		Y				Y
none	N	13:01	8/12/86	2	Y		Y				Y
	N			2							
	N			2							
	N			2							
	N			2							

Reference:

1) Biologic Response to Complex Blast Waves; D.Richmond, J.Yelverton, E.Fletcher, Y.Phillips; September,1985, (Pentolite).

2) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

COMP25 000 30 Inch Height
13:59:54.30 8-11-1986 Device 2 Channel 1 Shot 4
0.25 lbsC-4 2.5 ft HOB, 3.0 ft Range



Blast Overpressure Field Data
Case APC113SF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	1.22 m
Charge wt.	0.113 kgm
Charge type	Pentolite and C4

Blast Parameters:

Maximum Pressure	194.4 (243.6)	kPa
Positive duration (Ta)	0.72 (0.12)	ms
Positive Impulse (Ia)	17.4 (10.7)	kPa ms
Total Impulse (It)	578.9	kpa ms (20 ms)

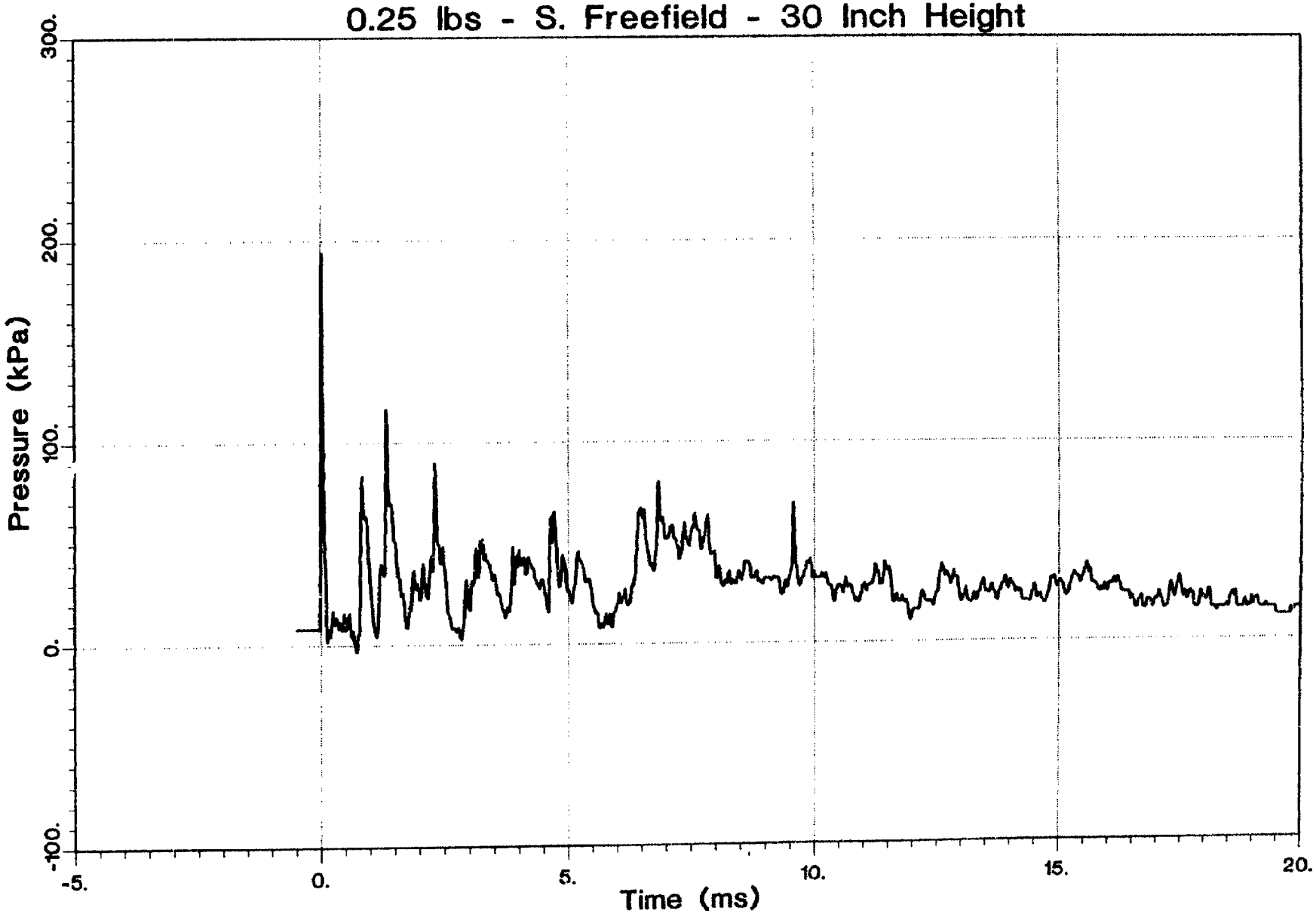
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							
	N			1							
	N			1							
	N			1							
none	N	14:00	8/11/86	2	Y		Y				Y
none	N	13:01	8/12/86	2	Y		Y				Y
	N			2							
	N			2							
	N			2							
	N			2							

Reference:

1) Biologic Response to Complex Blast Waves; D.Richmond, J.Yelverton, E.Fletcher, Y.Phillips; September,1985, (Pentolite).

2) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

COMP25 000 30 Inch Height
13:59:54.30 8-11-1986 Device 2 Channel 2 Shot 4
0.25 lbsC-4 2.5 ft HOB, 4.0 ft Range



Blast Overpressure Field Data
APC227NF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	500.3	(633) kPa
Positive duration (Ta)	30.0	(29.3) ms
Positive Impulse (Ia)	2384	(2145) kPa ms
Total Impulse (It)	2014	kpa ms (20 ms)

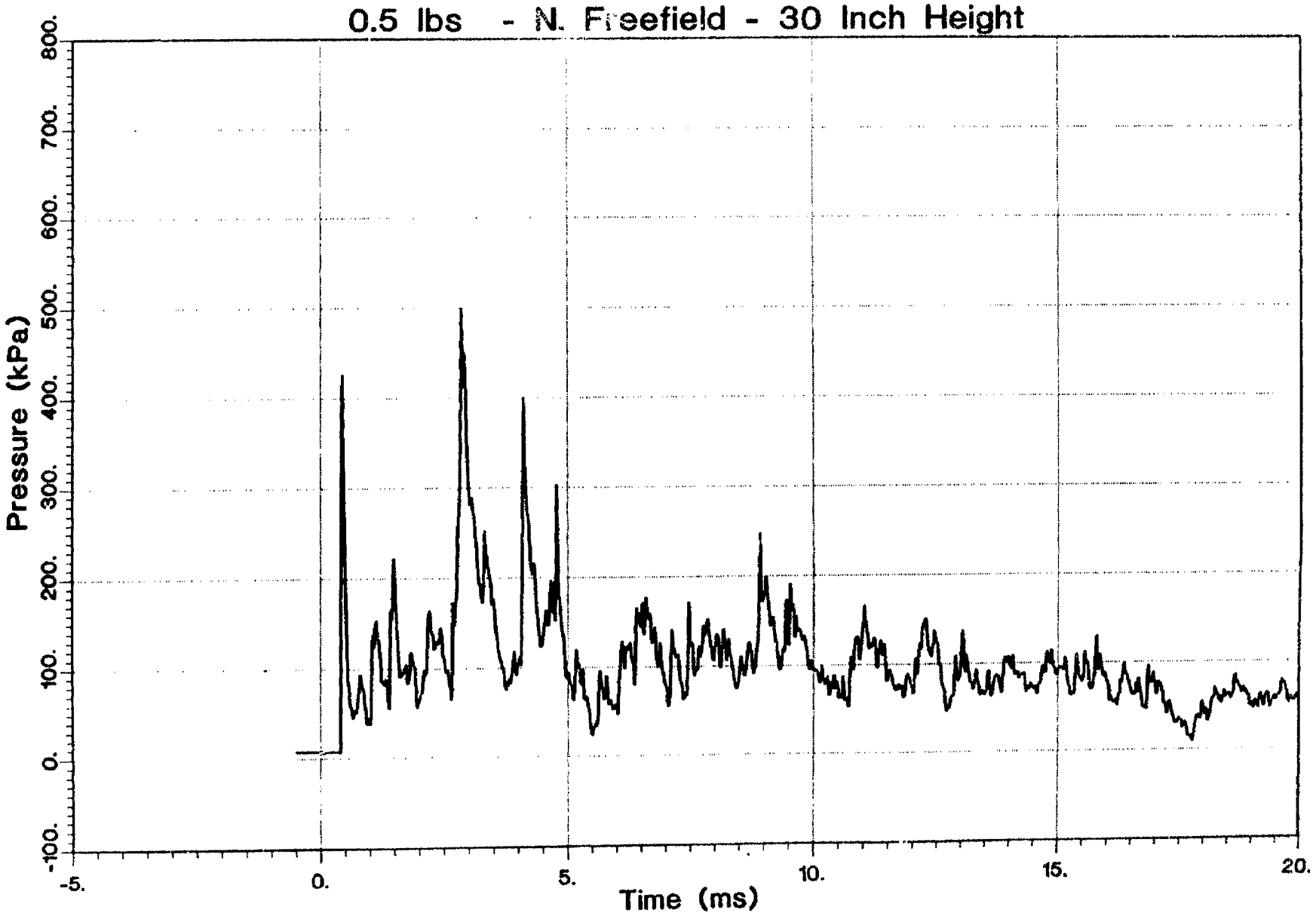
Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	E			1							
	M			1							
	M			1							
	TH			1							
	TH			1							
none		15:35	8/11/86	2	Y		Y				Y
none		14:07	8/12/86	2	Y		Y				Y

Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

2) Dr. Ken Dodd's field data

COMP50N 000 30 Inch Height
14:07:19.14 8-12-1986 Device 2 Channel 1 Shot 5
0.5 lbs C-4 2.5 ft HOB, 3.0 ft Range



Blast Overpressure Field Data
Case APC227SF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	1.22 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	705.6 (998.5)	kPa
Positive duration (Ta)	1.0 (0.17)	ms
Positive Impulse (Ia)	137.7 (55.7)	kPa ms
Total Impulse (It)	2276	kpa ms (20 ms)

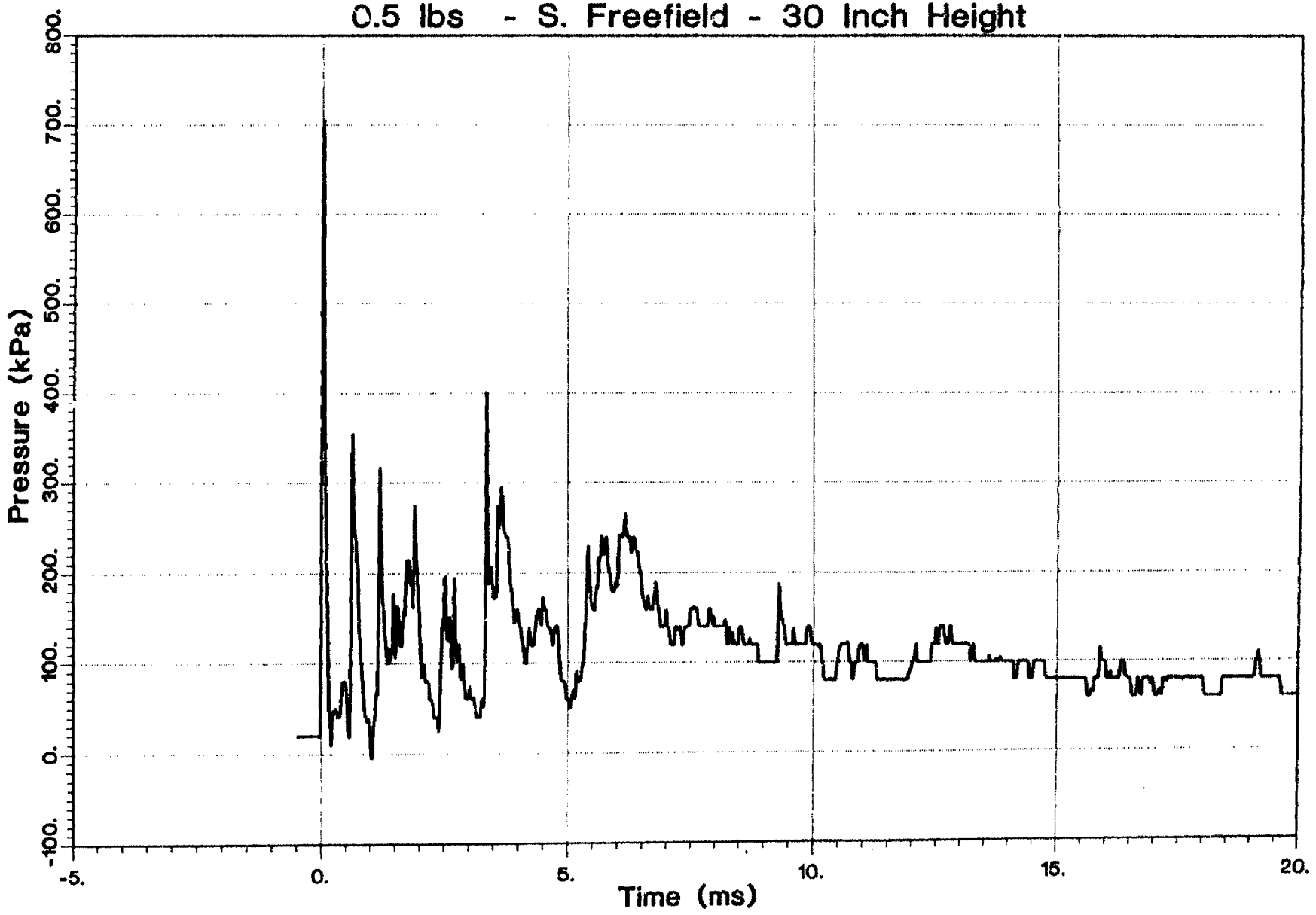
Animal ID	Shot: Injury Grade	Time	Date	Ref #	Data Collection: Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	E			1							
	E			1							
	M			1							
	TH			1							
	N			1							
none		15:35	8/11/86	2	Y		Y				Y
none		14:07	8/12/86	2	Y		Y				Y

Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

2) Dr. Ken Dodd's field data.

COMP50N 000 30 Inch Height
14:07:19.14 8-12-1986 Device 2 Channel 2 Shot 5
0.5 lbs C-4 2.5 ft HOB, 4.0 ft Range



Blast Overpressure Field Data
Case APC454NF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	0.91 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	461.6	(652.8)	kPa
Positive duration (Ta)	1.7	(1.5)	ms
Positive Impulse (Ia)	28.2	(28.2)	kPa ms
Total Impulse (It)	1750 (20ms)		kPa ms

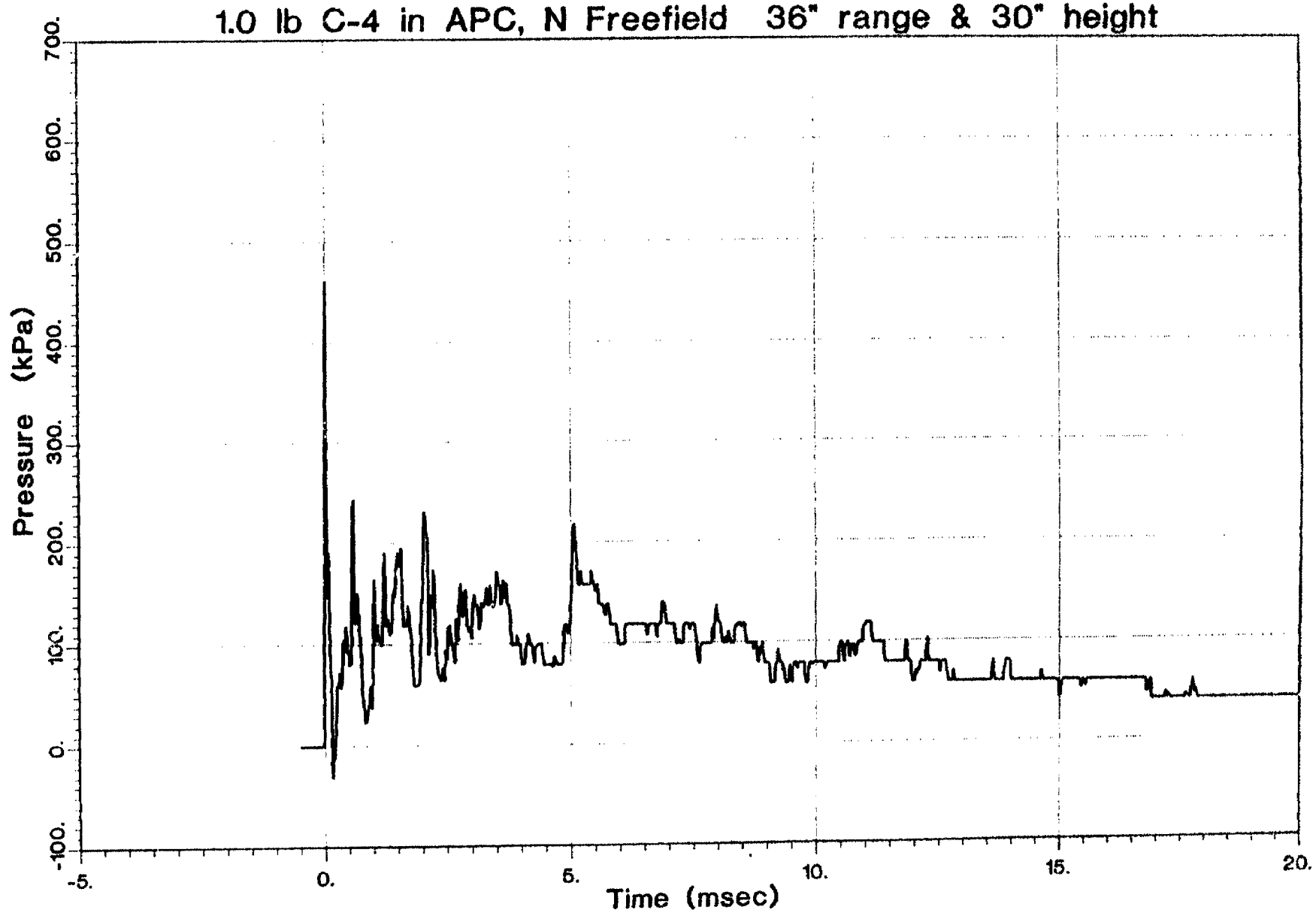
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
815	E	10:27	8/13/86	1,2	Y		Y				
	E	13:57	8/13/86	1,2	Y		Y				
	E			1							

Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

2) Dr Ken Dodd's field data.

COMP1 000 N Freefield 36" range & 30" height
10: 0:42:76 8/13/1986 Device 1 Channel 2 Shot 3
1.0 lbs C-4 2.5 ft HOB, 3.0 ft Range



Blast Overpressure Field Data
Case APC454SF
Location Albuquerque

Blast Conditions:

Geometry	APC
H.O.B.	0.76 m
Distance	1.22 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	366.1	(499.3)	kPa
Positive duration (Ta)	0.03	(0.14)	ms
Positive Impulse (Ia)	0.06	(20.0)	kPa ms
Total Impulse (It)	2101	(20ms)	kPa ms

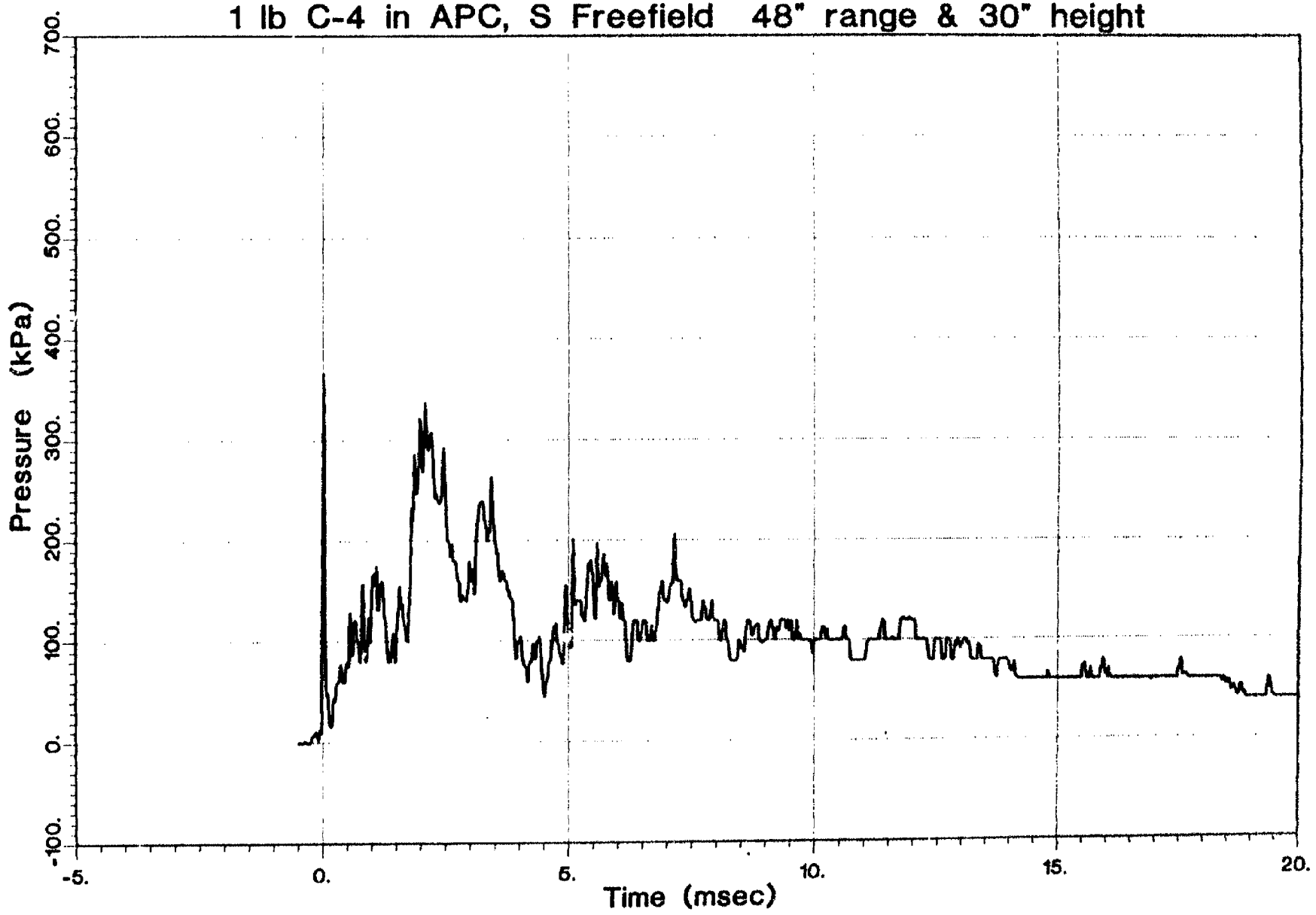
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
813	E	10:27	8/13/86	1,2	Y		Y				
815	E	13:57	8/13/86	1,2	Y		Y				
	E			1							

Reference:

1) Biological Effects of Complex Blast Waves From Explosions Inside An Enclosure; D.Richmond, J.Yelverton, W.Hicks, Y.Phillips; February, 1987, (C4).

2) Dr Ken Dodd's field notes.

COMP1N 000 S. Freefield 48 in
13: 0:39:20 8/13/1986 Device 1 Channel 1 Shot 71
1.0 lb C-4 2.5 ft HOB, 4.0 ft Range



BUNKER

Blast Overpressure Field Data
Case B213FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	1.22 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

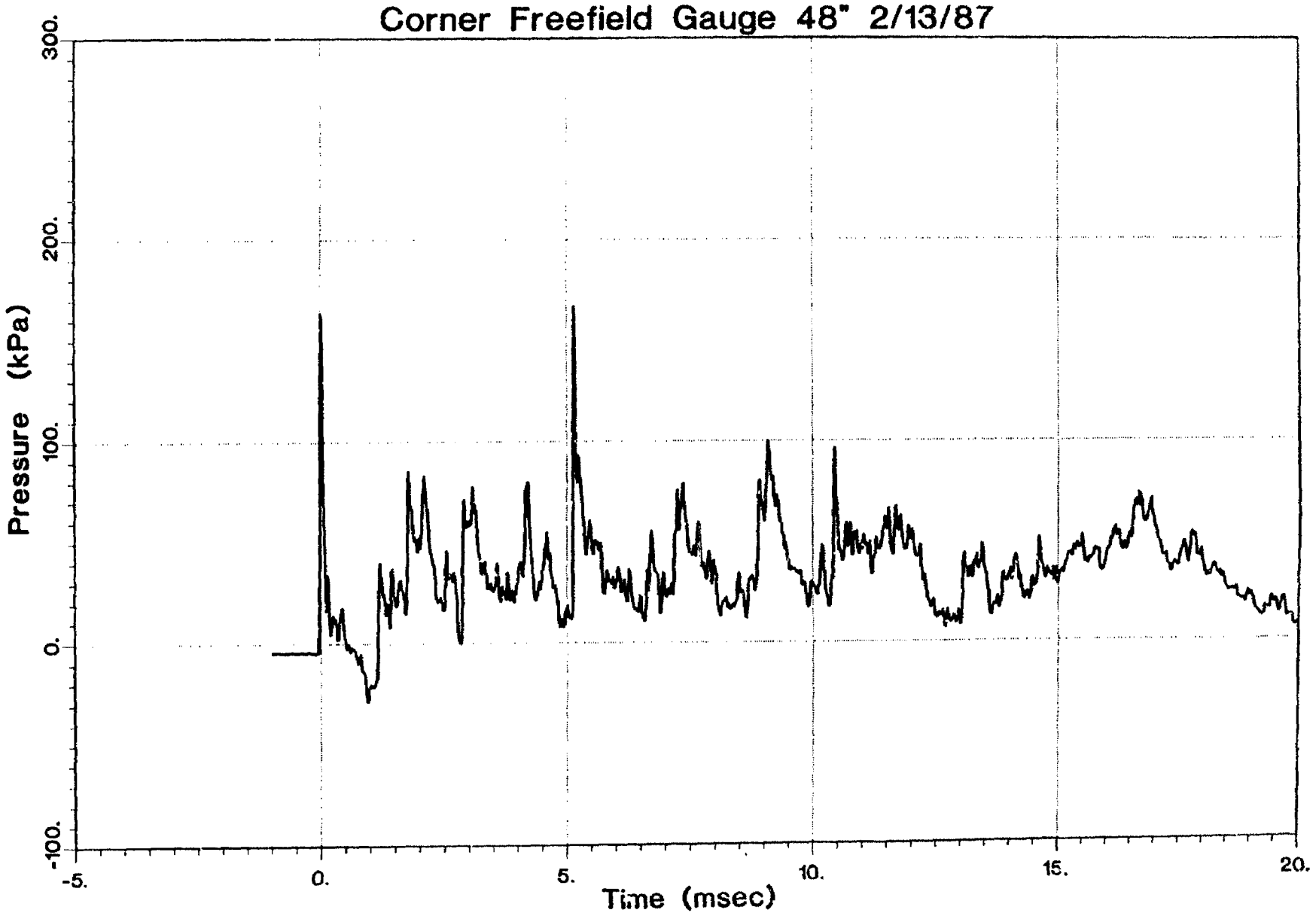
Maximum Pressure	166.8	(198.0)	kPa
Positive duration (Ta)	0.54	(0.2)	ms
Positive Impulse (Ia)	16.65	(13.6)	kpa ms
Total Impulse (It)	696.7	kpa ms (20 ms)	

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
23	N	18:04	2/13/87	1	Y		Y	Y			
24	N	18:04	2/13/87	1	Y		Y	Y			

Reference:

1) Field notes from Dr. Ken Dodd.

2-13-71 000 Corner
18: 0: 4:31 3/ 9/1987 Device 1 Channel 1 Shot 64
0.5 lb C-4 4.0 ft HOB, 4.0 ft Range



Blast Overpressure Field Data
Case B218FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	1.42 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

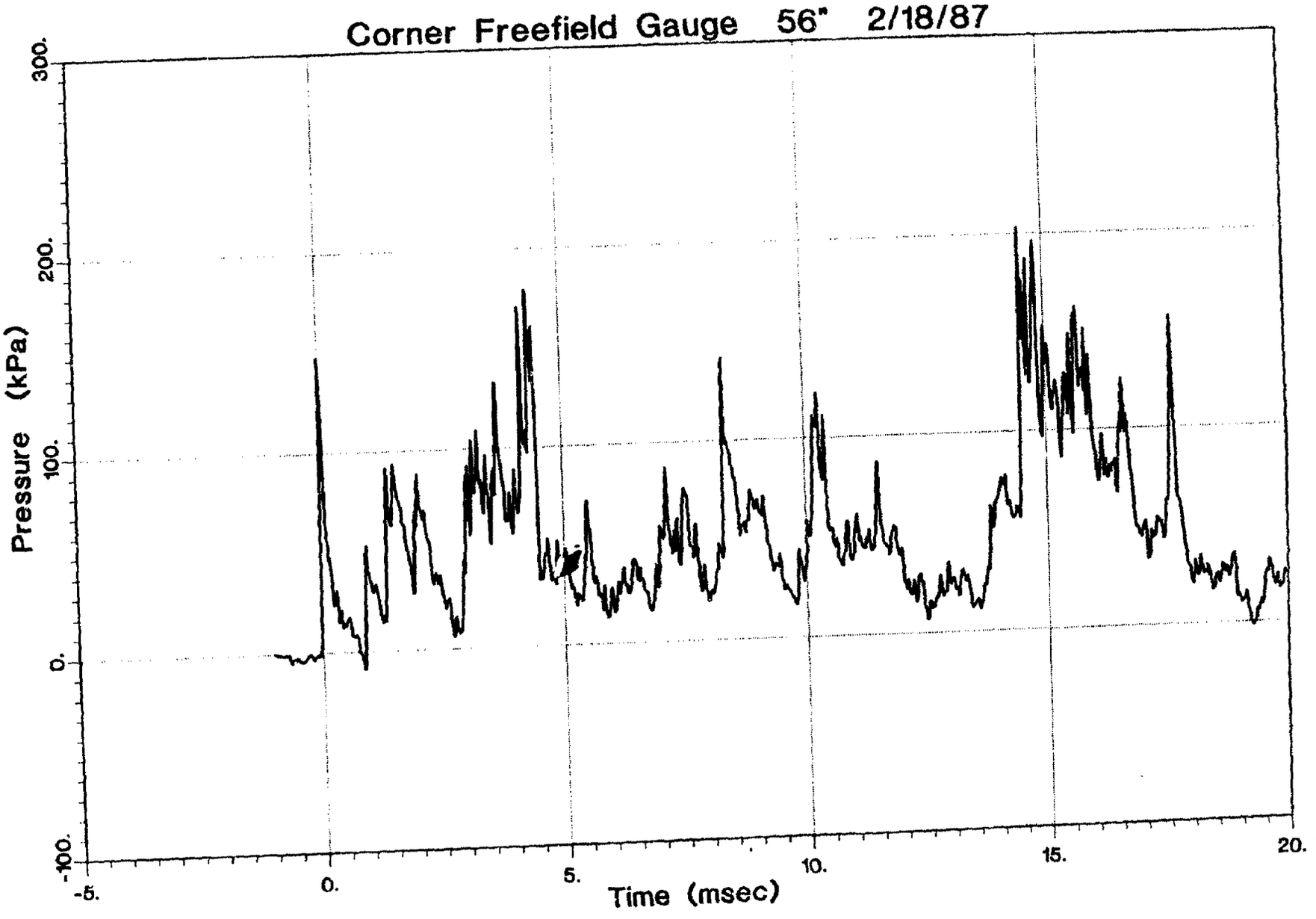
Maximum Pressure	203.1 (386.6) kPa
Positive duration (Ta)	0.8 (0.8) ms
Positive Impulse (Ia)	26.0 (26.5) kpa ms
Total Impulse (It)	1050.7 kpa ms (20 ms)

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
25	N	17:19	2/18/87	1	Y		Y	Y			
26	TH	17:19	2/18/87	1	Y		Y	Y			

Reference:

1) Field notes from Dr. Ken Dodd.

2-18-71 000 Corner
17: 0:19:60 3/ 9/1987 Device 1 Channel 1 Shot 63
0.5 lb C-4 4.0 ft HOB, 4.7 ft Range



Blast Overpressure Field Data
Case B220FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	1.42 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

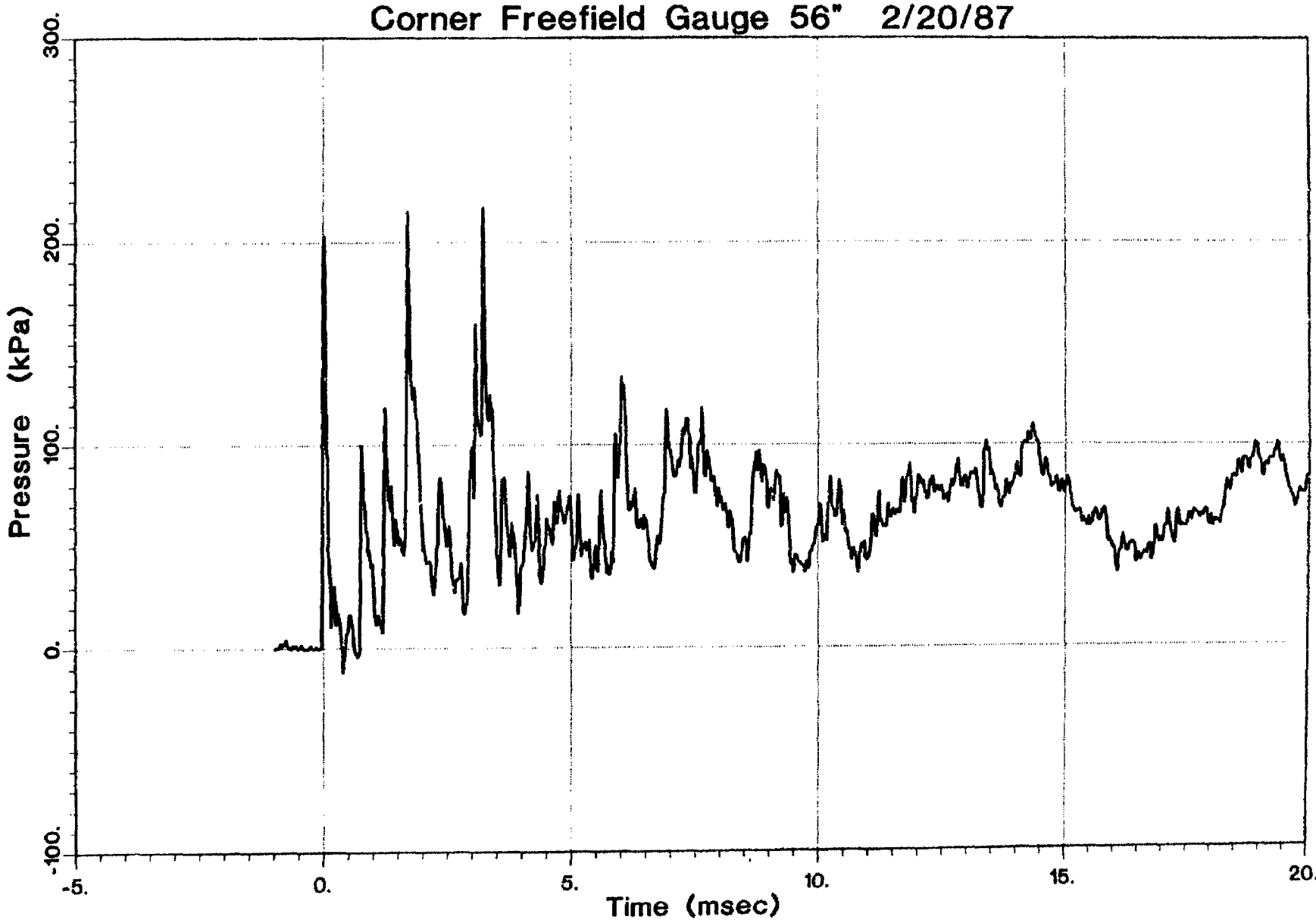
Maximum Pressure	217.1	(286.4)	kPa
Positive duration (Ta)	1.3	(0.4)	ms
Positive Impulse (Ia)	23.0	(22.7)	kpa ms
Total Impulse (It)	1281	kpa ms (20 ms)	

Animal ID	Injury Grade	Shot: Time	Date	Ref #	Data Collection: Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
27	TH	17:57	2/20/87	1	Y		Y	Y			
28	TH	17:57	2/20/87	1	Y		Y	Y			

Reference:

1) Field notes from Dr. Ken Dodd.

2-20-71 000 Corner
17: 0:57:25 3/ 9/1987 Device 1 Channel 1 Shot 36
1lb C-4 4ft HOB HOB, 4.7 ft Range



Blast Overpressure Field Data
Case B32FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	0.91 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

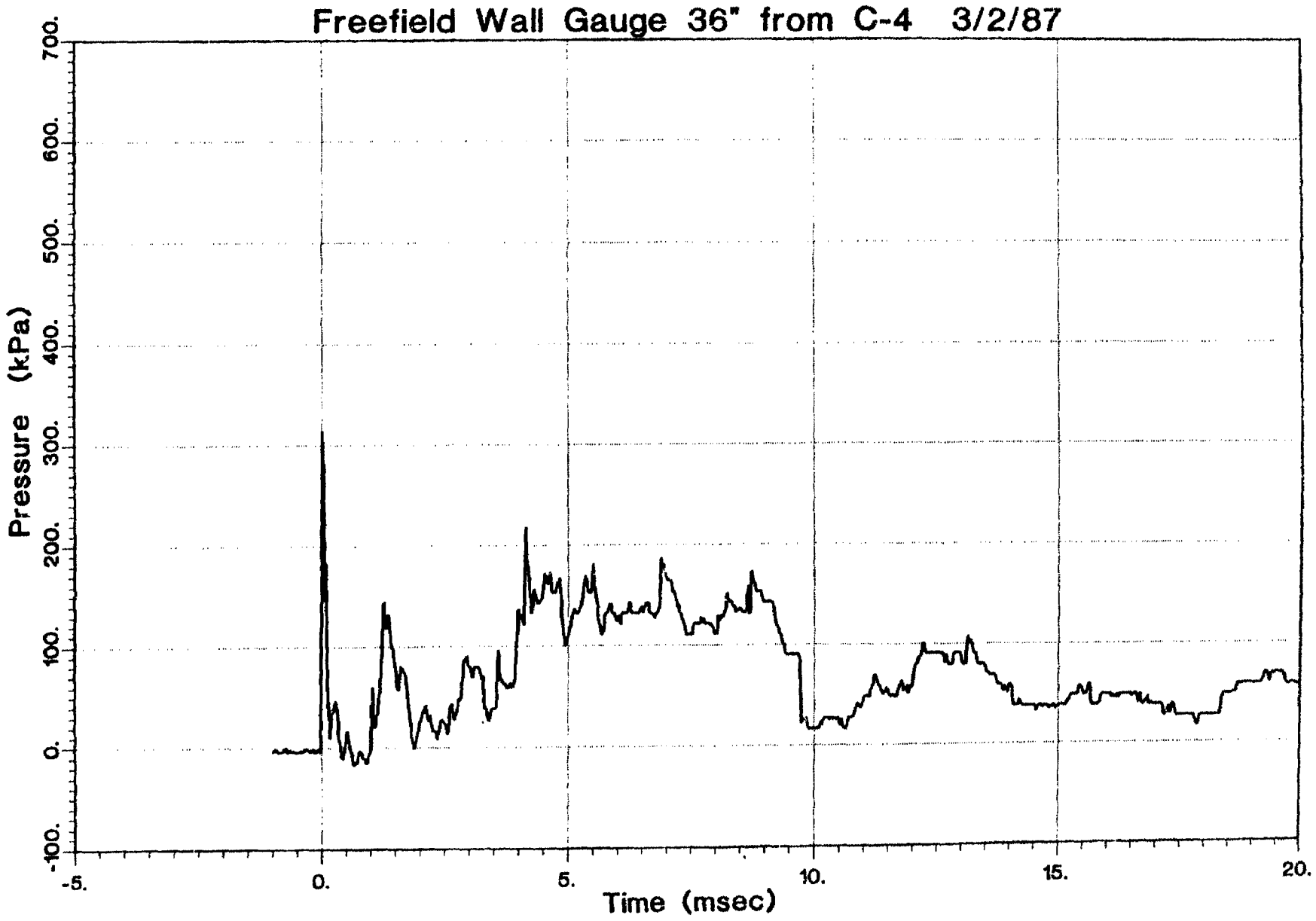
Maximum Pressure	314.2 (470.1)	kPa
Positive duration (Ta)	0.45 (0.17)	ms
Positive Impulse (Ia)	34.1 (27.9)	kpa ms
Total Impulse (It)	1430	kpa ms (20 ms)

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
29	TH	17:07	3/2/87	1	Y		Y	Y			
30	TH	17:07	3/2/87	1	Y		Y	Y			

Reference:

1) Field notes from Dr. Ken Dodd.

3-2-71 000 Wall
17: 0: 7:47 3/ 9/1987 Device 1 Channel 1 Shot 35
1lb C-4 Sphere 4ft HOB HOB, 3.0 ft Range



Blast Overpressure Field Data
Case B33FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	0.91 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

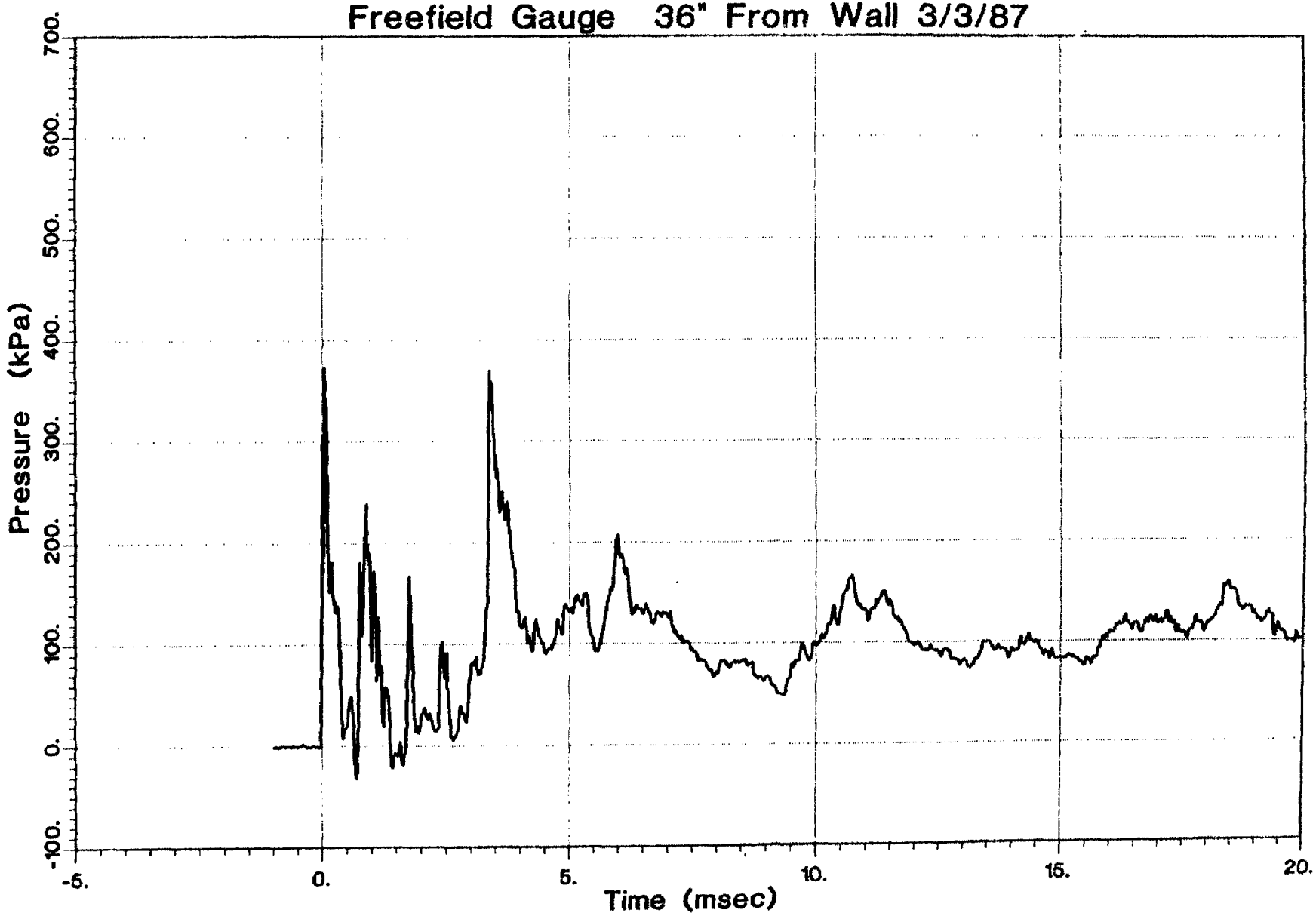
Maximum Pressure	373.5 (597.3)	kPA
Positive duration (Ta)	0.045 (0.66)	ms
Positive Impulse (Ia)	0.038 (80.4)	kpa ms
Total Impulse (It)	2009	kpa ms (20 ms)

Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
31	TH	17:31	3/3/87	1	Y		Y	Y			
32	TH	17:31	3/3/87	1	Y		Y	Y			

Reference:

1) Field notes from Dr. Ken Dodd.

3-3-71 000 Wall
17: 0:31:74 3/ 9/1987 Device 1 Channel 1 Shot 34
1lb C-4 Sphere 4ft HOB HOB, 3.0 ft Range



Blast Overpressure Field Data
Case B35FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	1.17 m
Charge wt.	0.227
Charge type	C4

Blast Parameters:

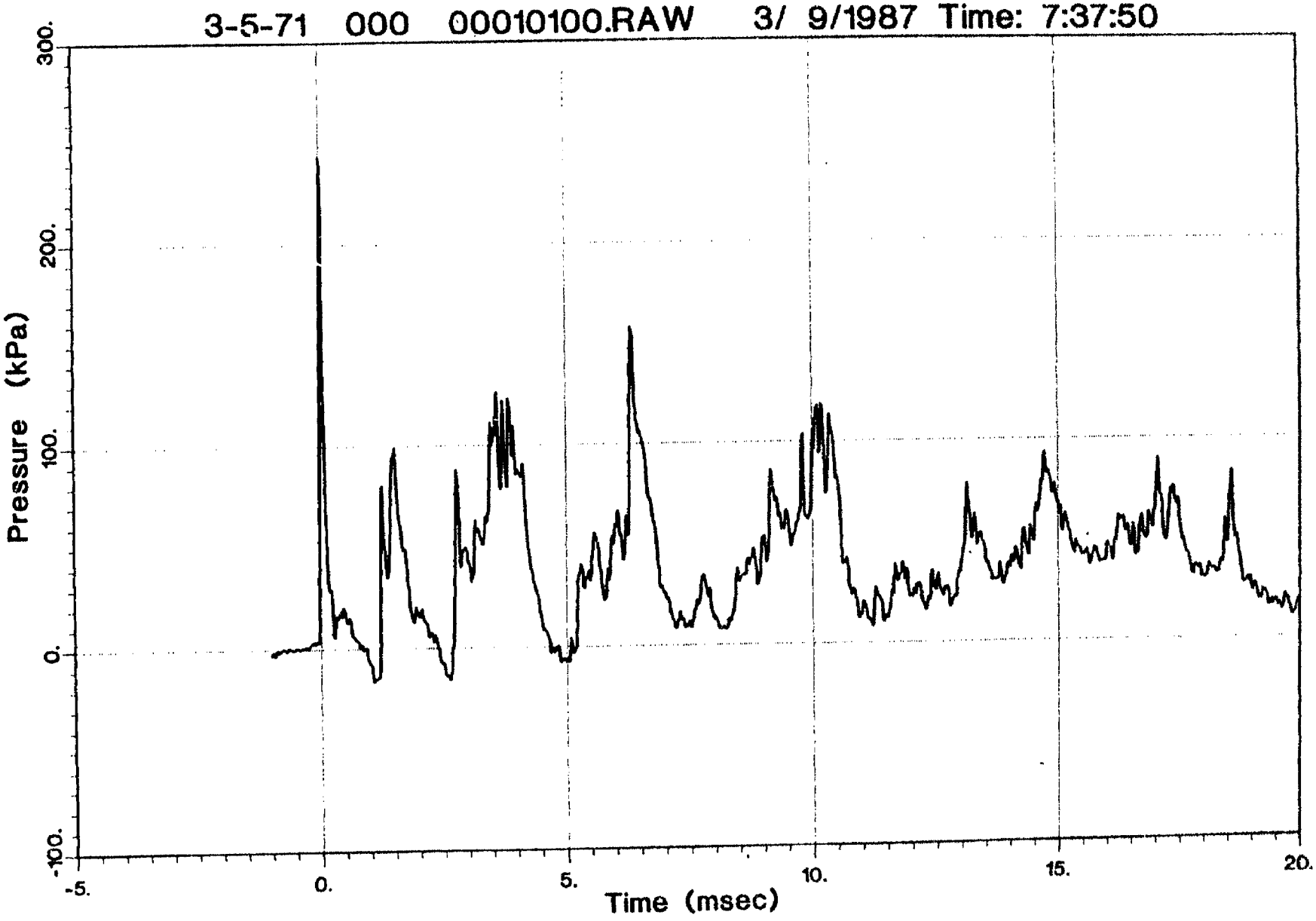
Maximum Pressure	243.7	(259.9)	kPa
Positive duration (Ta)	1.1	(0.9)	ms
Positive Impulse (Ia)	30.9	(30.3)	kpa ms
Total Impulse (It)	822	kpa ms (20 ms)	

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
33	TH	16:50	3/5/87	1	Y		Y	Y			
34	TH	16:50	3/5/87	1	Y		Y	Y			

Reference:

1) Field notes from Dr. Ken Dodd.

3-5-71 000 Wall
16: 0:50:38 3/ 9/1987 Device 1 Channel 1 Shot 32
0.5 lb C-4 Sphere 4.0 ft HOB, 3.8 ft Range



Blast Overpressure Field Data
Case B36FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	1.17 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

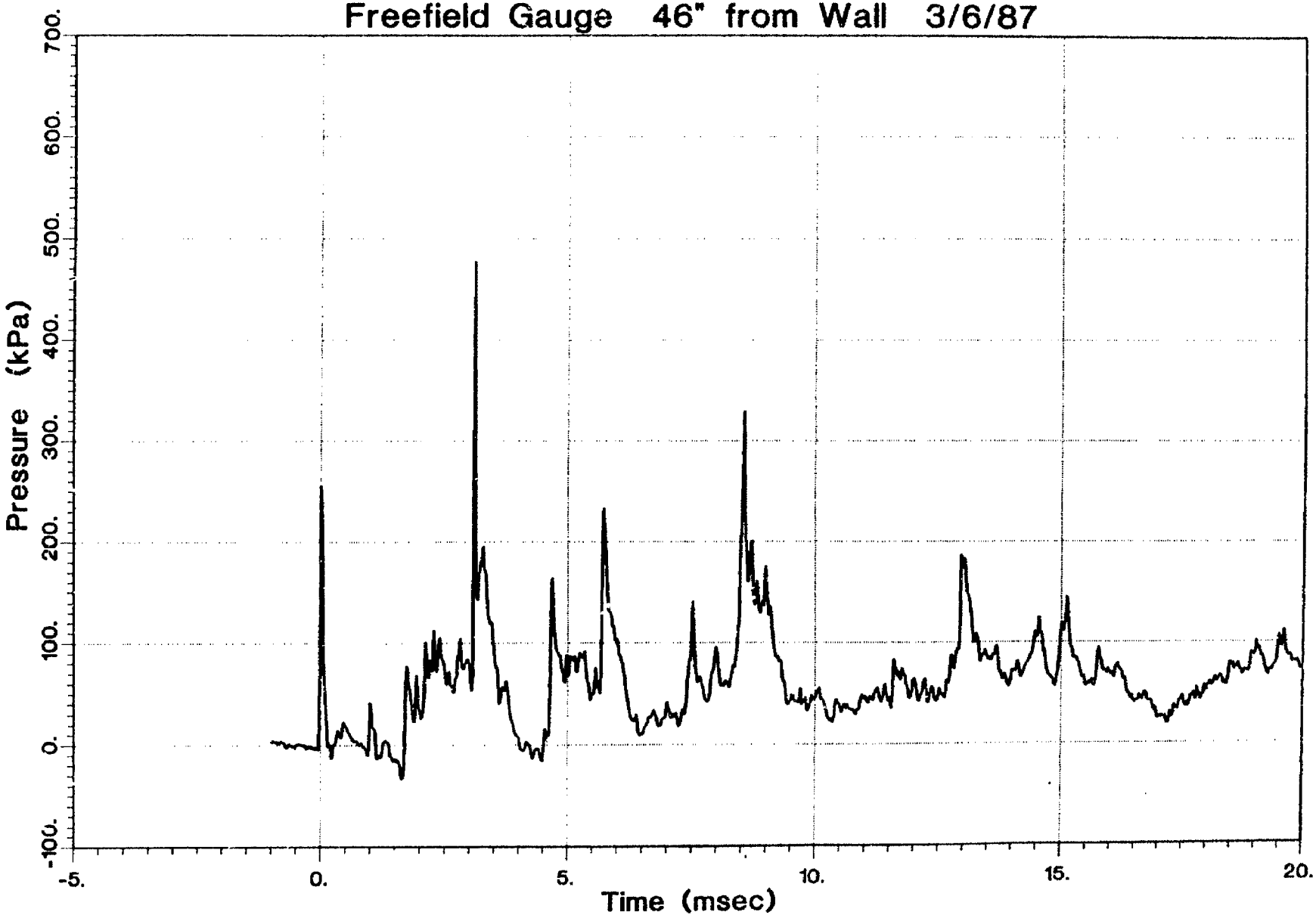
Maximum Pressure	477.7	(712.9)	kPa
Positive duration (Ta)	1.0	(0.16)	ms
Positive Impulse (Ia)	0.3	(17.7)	kpa ms
Total Impulse (It)	1205	kpa ms (20 ms)	

Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom Vic
35	TH	15:03	3/6/87	1	Y		Y	Y		
36	M	15:03	3/6/87	1	Y		Y	Y		

Reference:

1) Field notes from Dr. Ken Dodd.

3-6-71 000 wall
15: 0: 3:99 3/ 9/1987 Device 1 Channel 1 Shot 33
1.0 lb C-4 4.0 ft HOB, 46 in Range



Blast Overpressure Field Data
Case B617FF
Location Albuquerque

Blast Conditions:

Geometry	Bunker
H.O.B.	1.22 m
Distance	1.22 m
Charge wt.	1.362 kgm
Charge type	C4

Blast Parameters:

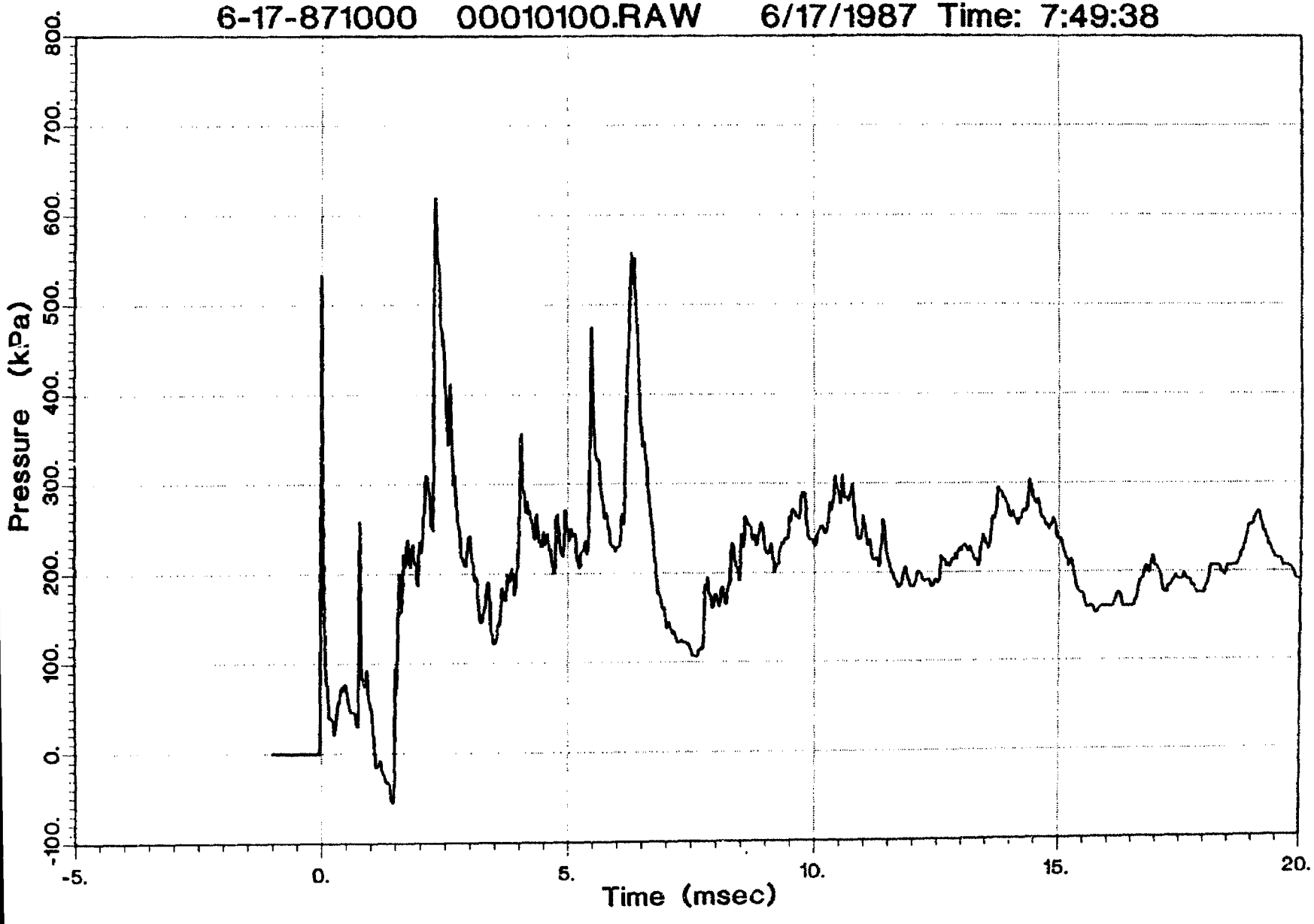
Maximum Pressure	620.4	(742.9)	kPa
Positive duration (Ta)	1.13	(1.11)	ms
Positive Impulse (Ia)	91.0	(91.2)	kpa ms
Total Impulse (It)	4067	kpa ms (20 ms)	

Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
		09:38	6/17/87	1	Y		Y	Y			

Reference:

1) Digitized data

6-17-871000 wall
9: 0:38:71 6/17/1987 Device 1 Channel 1 Shot 65
3.0 lb C-4 4.0 ft HOB, 4.0 ft Range



SUMMER STUDIES 85, 86 AND 87

Blast Overpressure Field Data
Case SS85C1
Location Albuquerque

Blast Conditions:

Geometry	Free Field multi-shot
H.O.B.	1.1 m
Distance	4.91 m
Charge wt.	1.362 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	82.2 kpa
Positive duration (Ta)	3.5 ms
Positive Impulse (Ia)	104.0 kpa ms
Total Impulse (It)	-1.0 kpa ms (20 ms)

	Shot:				Data Collection:				
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
D05	N			1		Y		Y	Y		
D06	N			1		Y		Y	Y		
D07	N			1		Y		Y	Y		
D13	N			1		Y		Y	Y		
D15	N			1		Y		Y	Y		
	N										

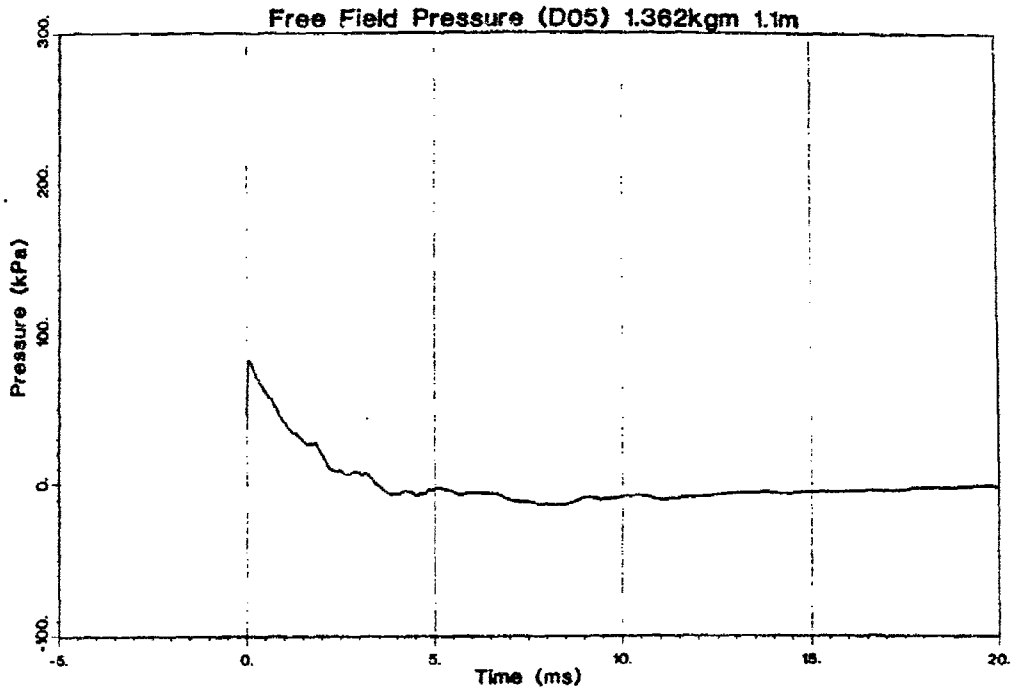
Reference:

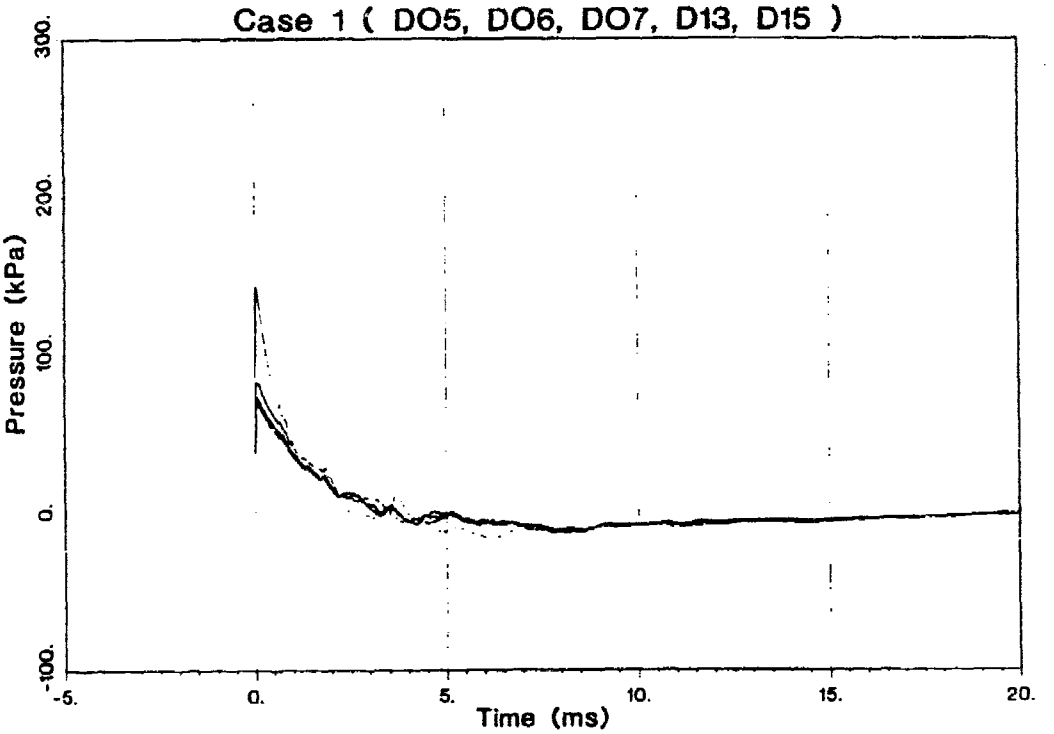
1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

D05 Free Field Pressure
11:17:00 07/12/85 Device 1 Channel 1 Shot 6
3.0 lb C-4 3.6 ft HOB, 16.1 ft Range





Blast Overpressure Field Data
Case SS85C2
Location Albuquerque

Blast Conditions:

Geometry	Free Field multi-shot
H.O.B.	0.91 m
Distance	3.26 m
Charge wt.	1.362 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	141.8	kpa
Positive duration (Ta)	2.5	ms
Positive Impulse (Ia)	110.2	kpa ms
Total Impulse (It)	4.1	kpa ms (20 ms)

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom Vic
D08	M			1		Y		Y	Y	
D09	M			1		Y		Y	Y	
D11	M			1		Y		Y	Y	
	M			1						
	M			1						

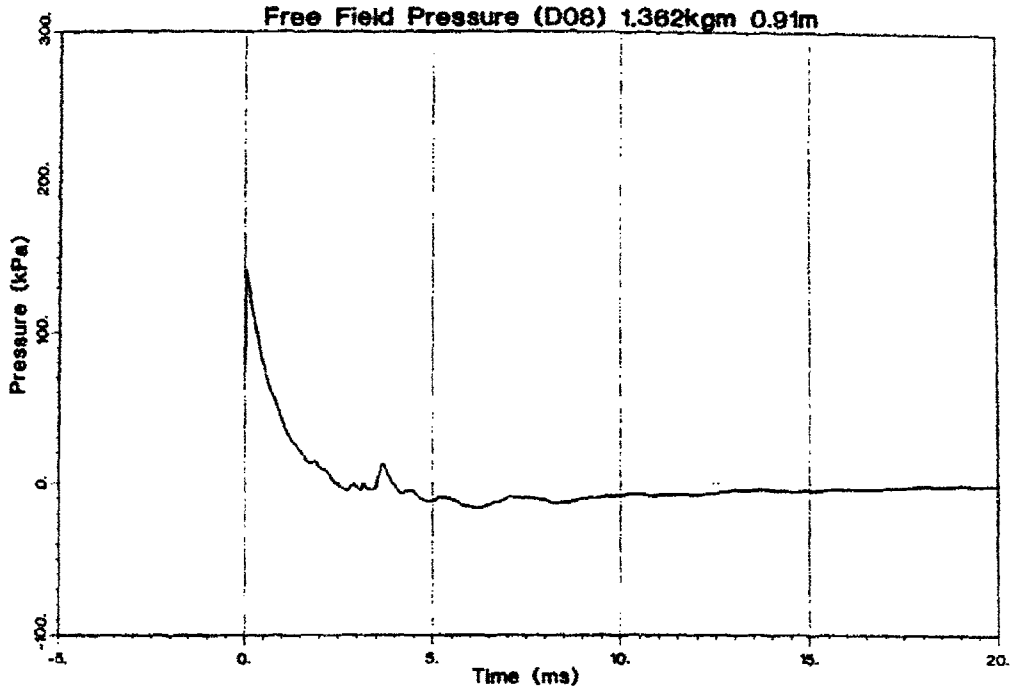
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

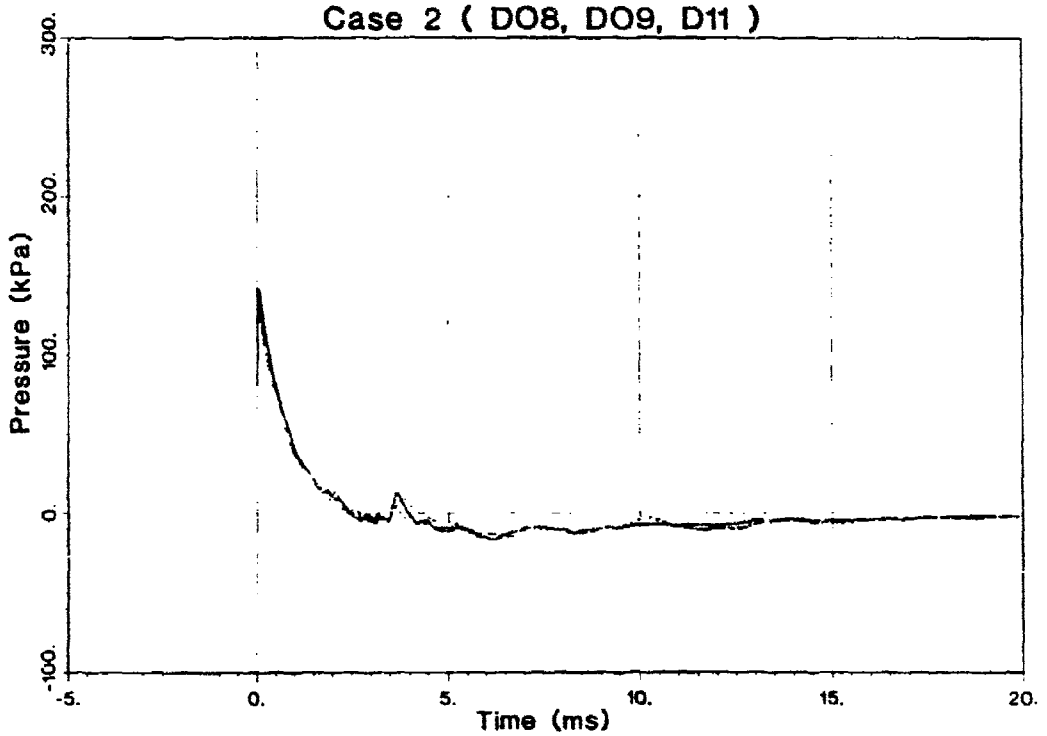
2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

D08 Free Field Pressure
11:45:00 07/16/85 Device 1 Channel 1 Shot 9
3.0 lb C-4 3.0 ft HOB, 10.7 ft Range



Summer Study 85
Case 2 (D08, D09, D11)



Blast Overpressure Field Data
Case SS85C3
Location Albuquerque

Blast Conditions:

Geometry	Free Field multi-shot
H.O.B.	0.24 m
Distance	1.71 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	253.4	kpa
Positive duration (Ta)	1.4	ms
Positive Impulse (Ia)	84.9	kpa ms
Total Impulse (It)	52.2	kpa ms (20 ms)

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
D21	E			1		Y		Y	Y		
D23	E			1		Y		Y	Y		
	E			1							
	E			1							

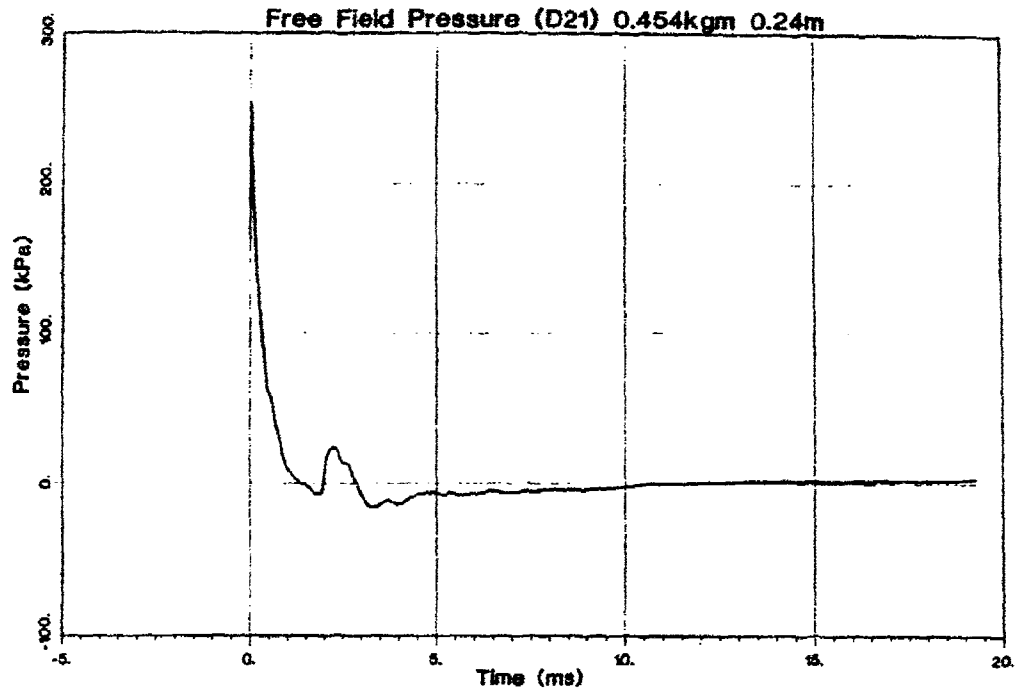
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

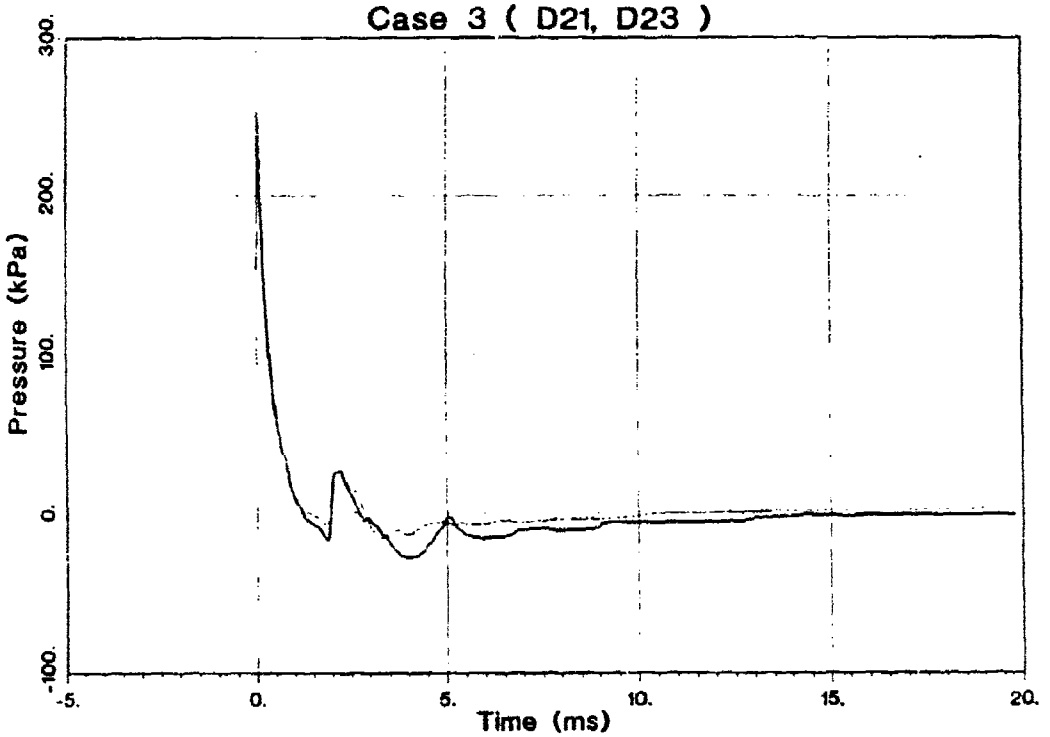
3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

D21 Free Field Pressure
11:51:00 08/01/85 Device 1 Channel 1 Shot 24
1.0 lb C-4 0.5 ft HOB, 5.7 ft Range



Summer Study 85

Case 3 (D21, D23)



Blast Overpressure Field Data
Case SS85C4
Location Albuquerque

Blast Conditions:

Geometry	Free Field multi-shot
H.O.B.	0.305 m
Distance	1.77 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	141.8	kpa
Positive duration (Ta)	1.4	ms
Positive Impulse (Ia)	58.7	kpa ms
Total Impulse (It)	-20.3	kpa ms (20 ms)

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom Vic
D17	M			1		Y		Y	Y	
D18	M			1		Y		Y	Y	
D19	M			1		Y		Y	Y	
D20	M			1		Y		Y	Y	

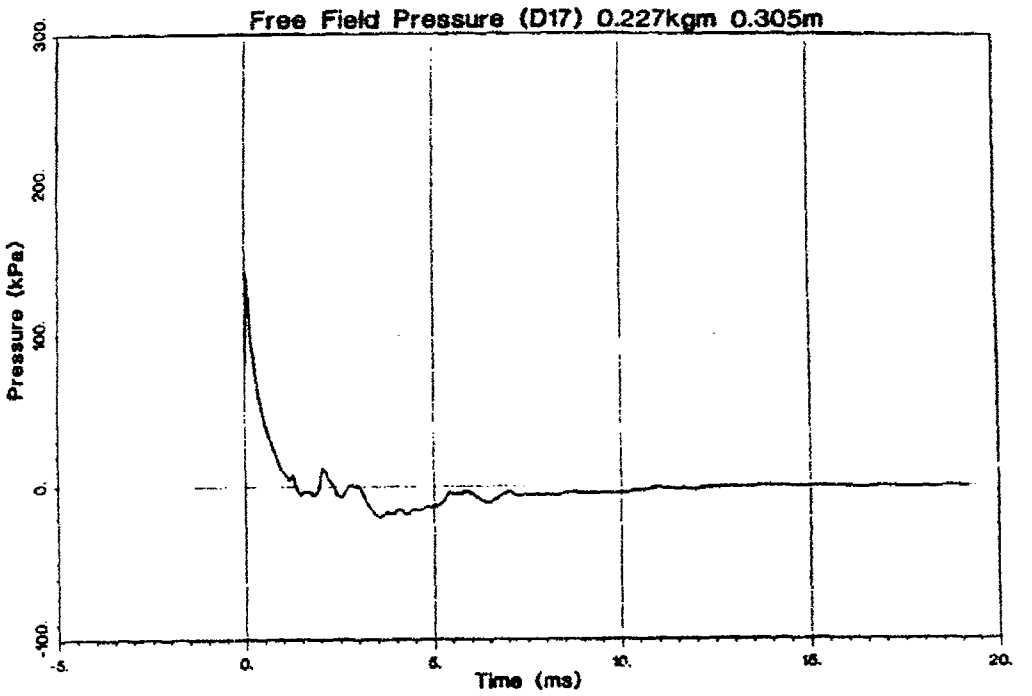
Reference:

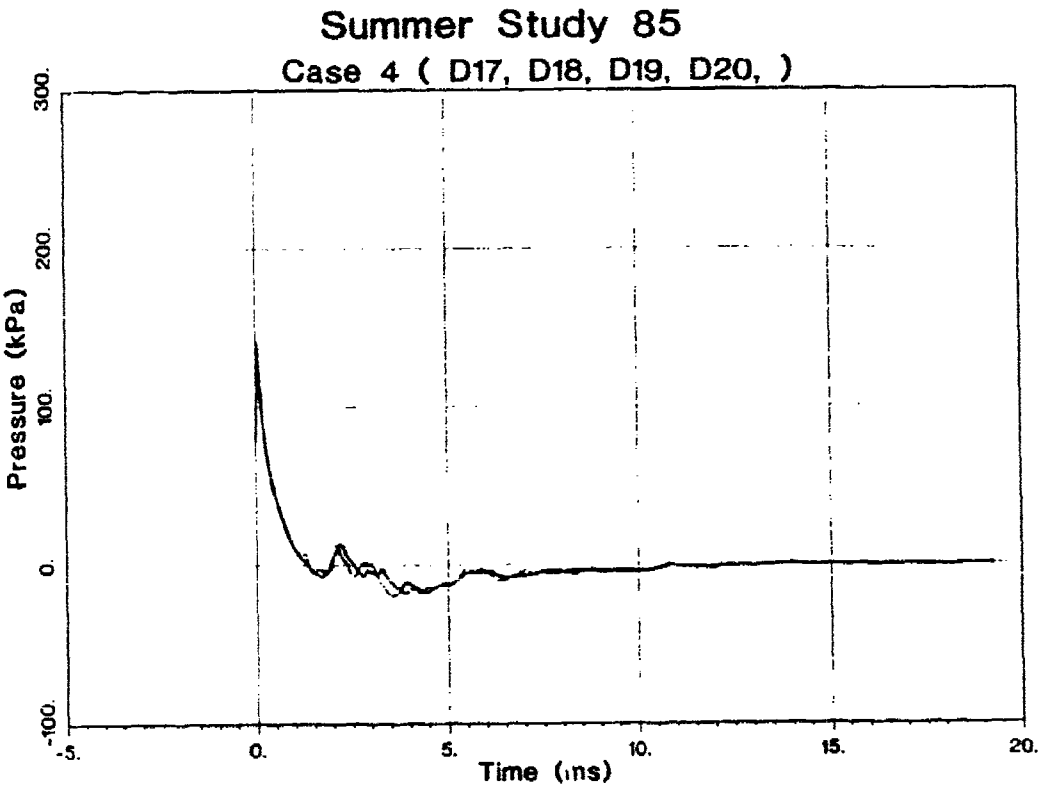
1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

D17 Free Field Pressure
11:50:00 07/30/85 Device 1 Channel 1 Shot 17
0.5 lb C-4 1.0 ft HOB, 5.8 ft Range





Blast Overpressure Field Data
Case SS85C5
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.91 m
Distance	4.02 m
Charge wt.	3.632 kgm
Charge type	C4

Blast Parameters: No Data
Maximum Pressure
Positive duration (Ta)
Positive Impulse (Ia)
Total duration (Td)
Total Impulse (It)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
				1							
				1							
				1							
				1							

Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

Blast Overpressure Field Data
Case SS85C6
Location Albuquerque

Blast Conditions:

Geometry	Free Field multi-shot
H.O.B.	1.83 m
Distance	9.15 m
Charge wt.	29.09 kgm
Charge type	TNT

Blast Parameters: No Data

- Maximum Pressure
- Positive duration (Ta)
- Positive Impulse (Ia)
- Total duration (Td)
- Total Impulse (It)

Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
				1							
				1							
				1							
				1							

Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

Blast Overpressure Field Data
Case SS86C1
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	1.1 m
Distance	4.91 m
Charge wt.	1.362 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	78.6 kpa
Positive duration (Ta)	3.5 ms
Positive Impulse (Ia)	100.8 kpa ms
Total Impulse (It)	13.8 kpa ms (20 ms)

Shot:				Data Collection:							
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
P19				1	Y	Y	Y	Y	Y	Y	
P20				1	Y	Y	Y	Y	Y	Y	
				1							
				1							
				1							
				1							

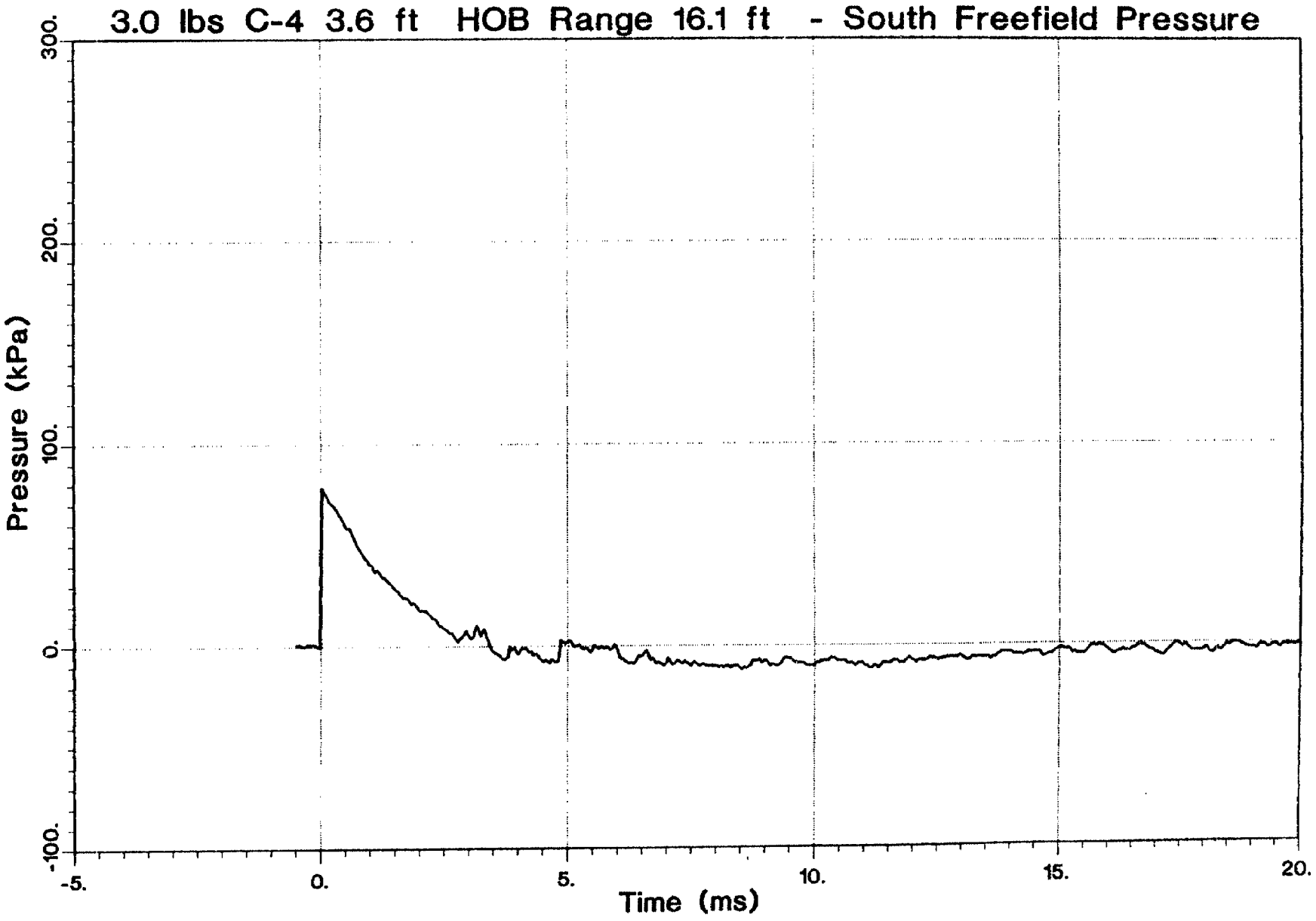
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP1920E000 South Freefield Pressure
13:00:44. 3 8-05-1986 Device 3 Channel 1 Shot 25
3.0 lbs C-4 Sphe 3.6 ft HOB, 16.1 ft Range



Blast Overpressure Field Data
Case SS86C2
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.91 m
Distance	3.26 m
Charge wt.	1.362 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	199.0	kpa
Positive duration (Ta)	2.1	ms
Positive Impulse (Ia)	148.3	kpa ms
Total Impulse (It)	-34.5	kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
P14,A15		12:04	7/29/86	1	Y	Y	Y	Y	Y	Y	
P13,A14		12:32	7/28/87	1	Y	Y	Y	Y	Y	Y	
A3		13:57	7/1/86	1	Y		Y			Y	
A1,A2		15:22	6/30/86	1	Y		Y			Y	
				1							

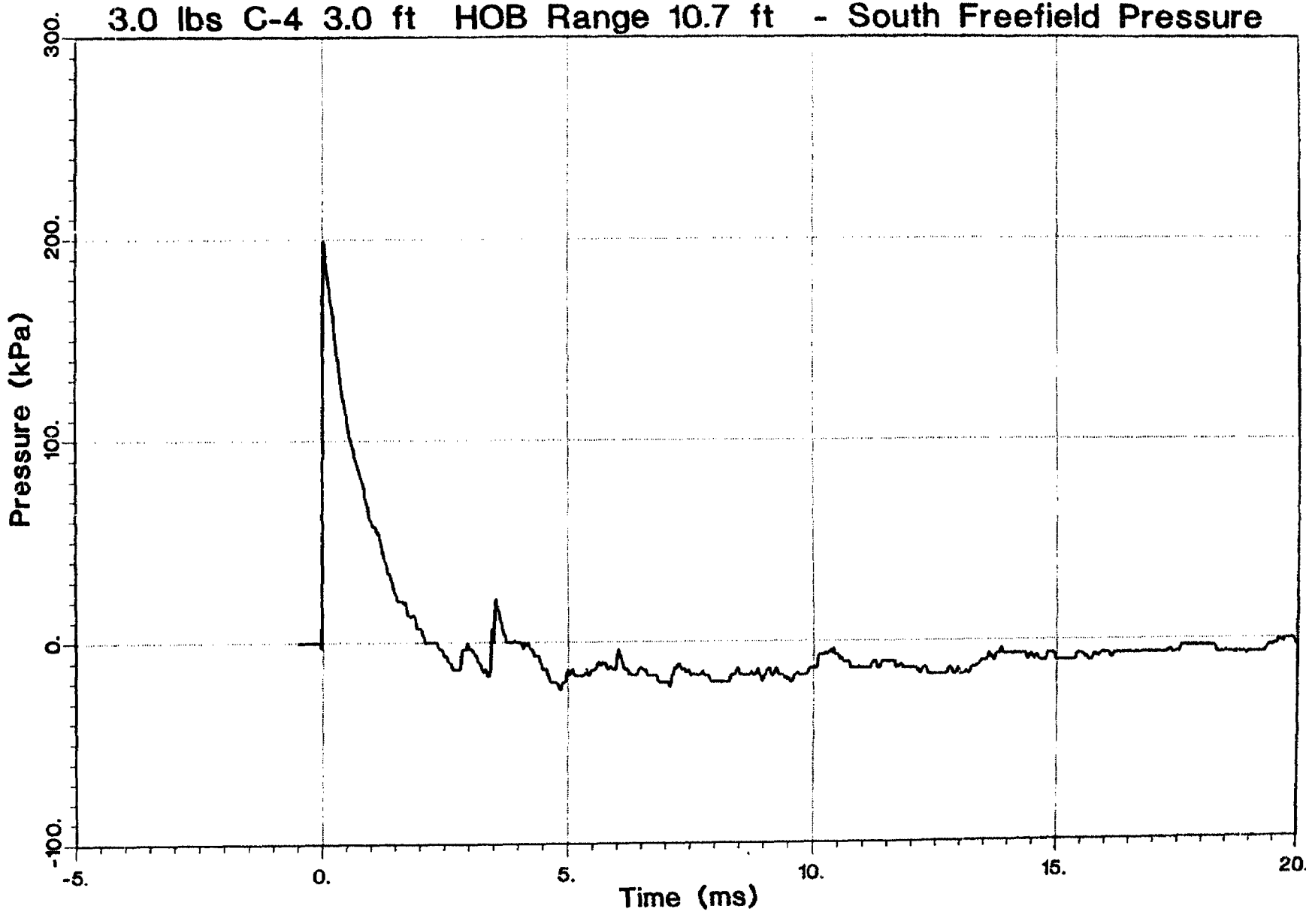
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP14A15000 South Freefield Pressure
12:04:55.99 7-29-1986 Device 3 Channel 1 Shot 26
3.0 lbs C-4 Sphe 3.0 ft HOB, 10.7 ft Range



Blast Overpressure Field Data
Case SS86C3
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.24 m
Distance	1.71 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	313.0	kpa
Positive duration (Ta)	1.6	ms
Positive Impulse (Ia)	95.4	kpa ms
Total Impulse (It)	29.4	kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
P15,A16		12:12	7/30/86	1	Y	Y	Y	Y	Y	Y	
P16		13:44	8/1/86	1	Y	Y	Y	Y	Y		
P16		12:57	8/1/86	1	Y	Y	Y	Y	Y		
				1							

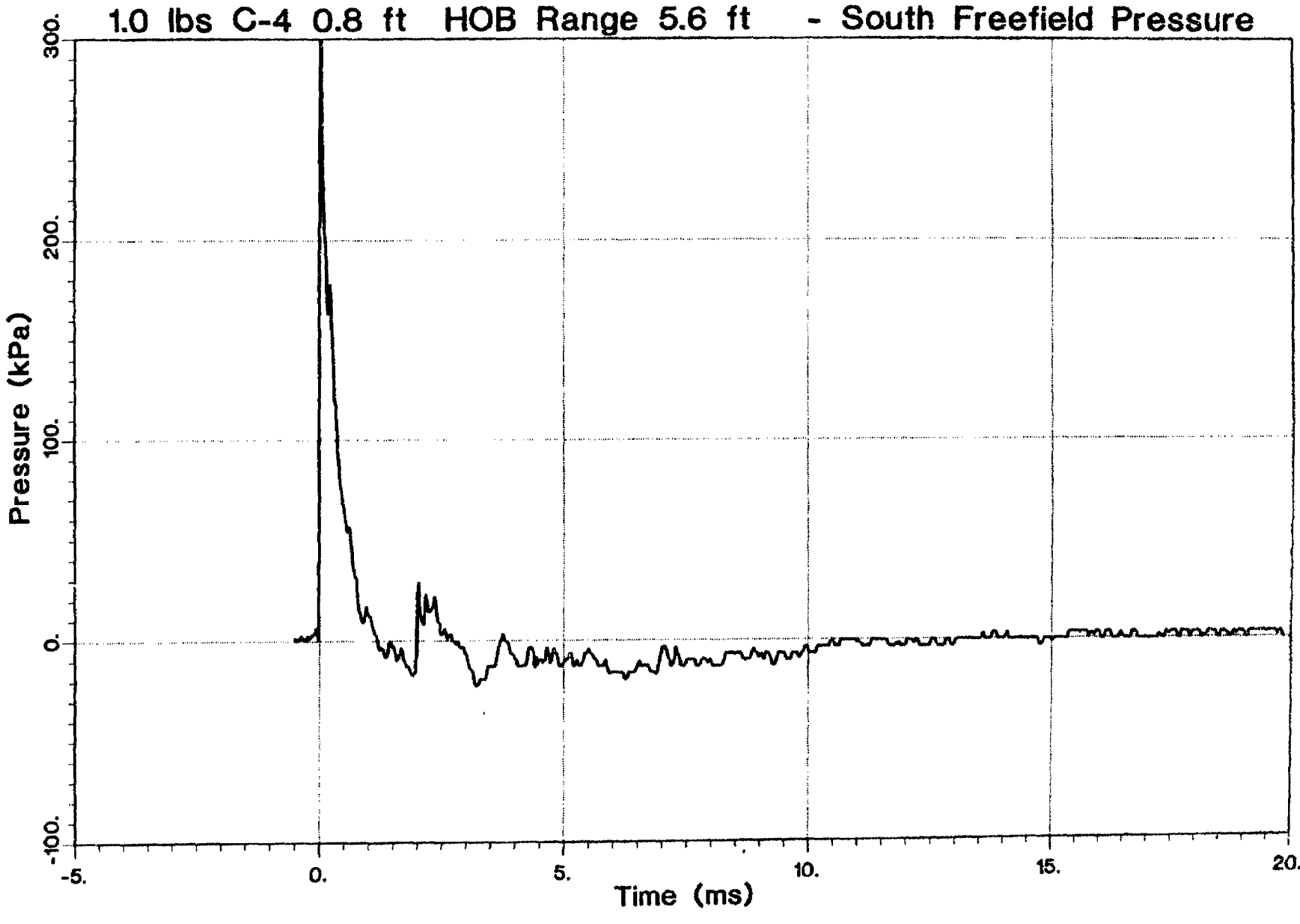
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP16 001 South Freefield Pressure
13:45:12.36 8-01-1986 Device 2 Channel 1 Shot 27
1.0 lbs C-4 Sphe 0.8 ft HOB, 5.6 ft Range



Blast Overpressure Field Data
Case SS86C4
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.305 m
Distance	1.77 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	188.7	kpa
Positive duration (Ta)	1.9	ms
Positive Impulse (Ia)	86.5	kpa ms
Total Impulse (It)	177.9	kpa ms (20 ms)

Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom Vic
P17,P18		13:31	8/4/86	1	Y	Y	Y	Y	Y	Y
P17,P18		13:52	8/4/86	1	Y	Y	Y	Y	Y	Y
				1						
				1						

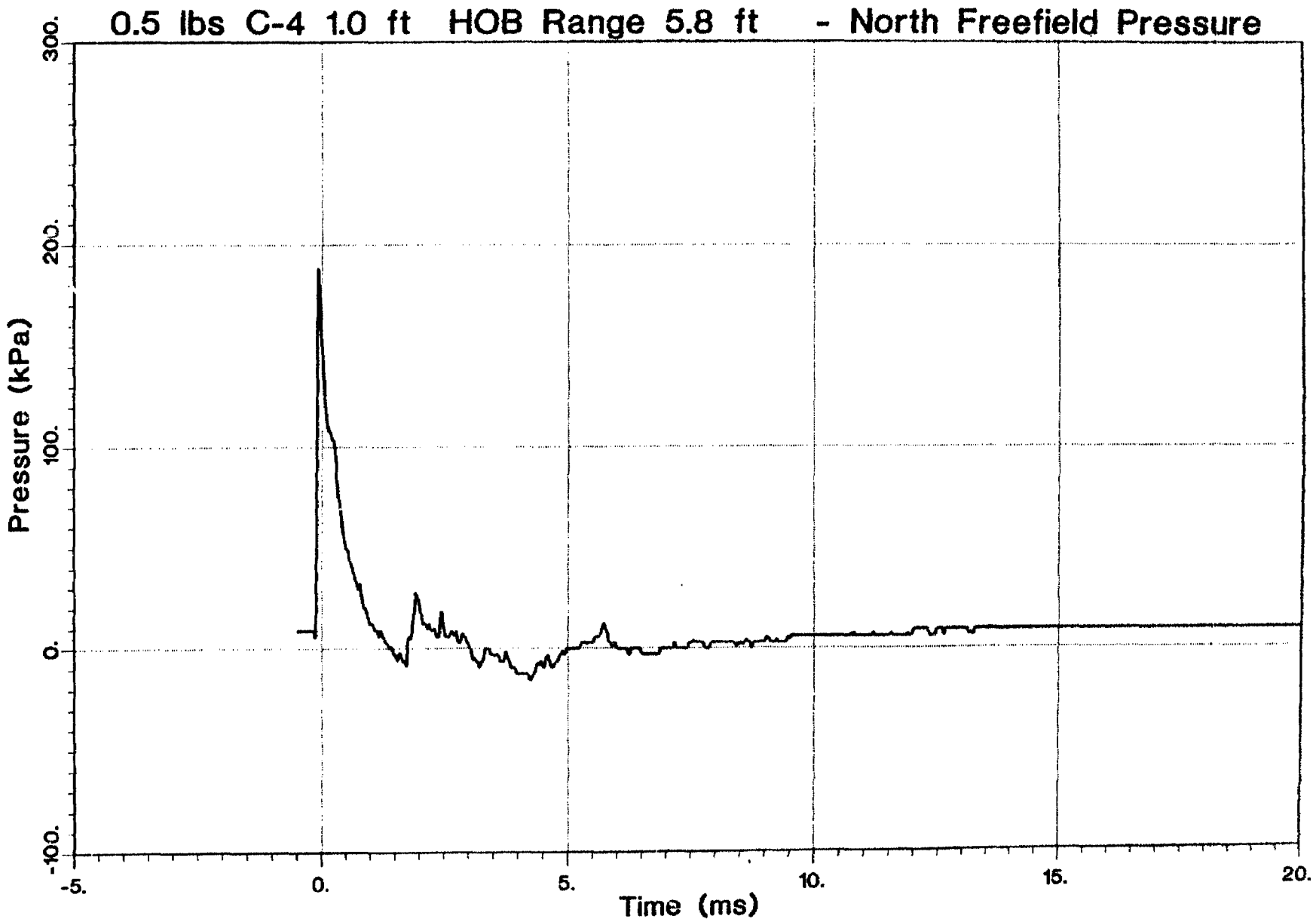
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP1718 000 North Freefield Pressure
13:31:49.46 8-04-1986 Device 3 Channel 2 Shot 28
0.5 lbs C-4 Sphe 1.0 ft HOB, 5.8 ft Range



Blast Overpressure Field Data
Case SS86C5
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.91 m
Distance	4.02 m
Charge wt.	3.632 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	202.4 kpa
Positive duration (Ta)	3.3 ms
Positive Impulse (Ia)	199.2 kpa ms
Total Impulse (It)	108.5 kpa ms (20 ms)

	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom Vic
P6,A7		13:17	7/9/86	1	Y	Y	Y	Y	Y	Y
P5,A6		13:03	7/8/86	1	Y	Y	Y	Y	Y	Y
P4,A5		13:17	7/7/86	1	Y	Y	Y	Y	Y	Y
P7,A8		13:11	7/10/86	1	Y	Y	Y	Y	Y	Y

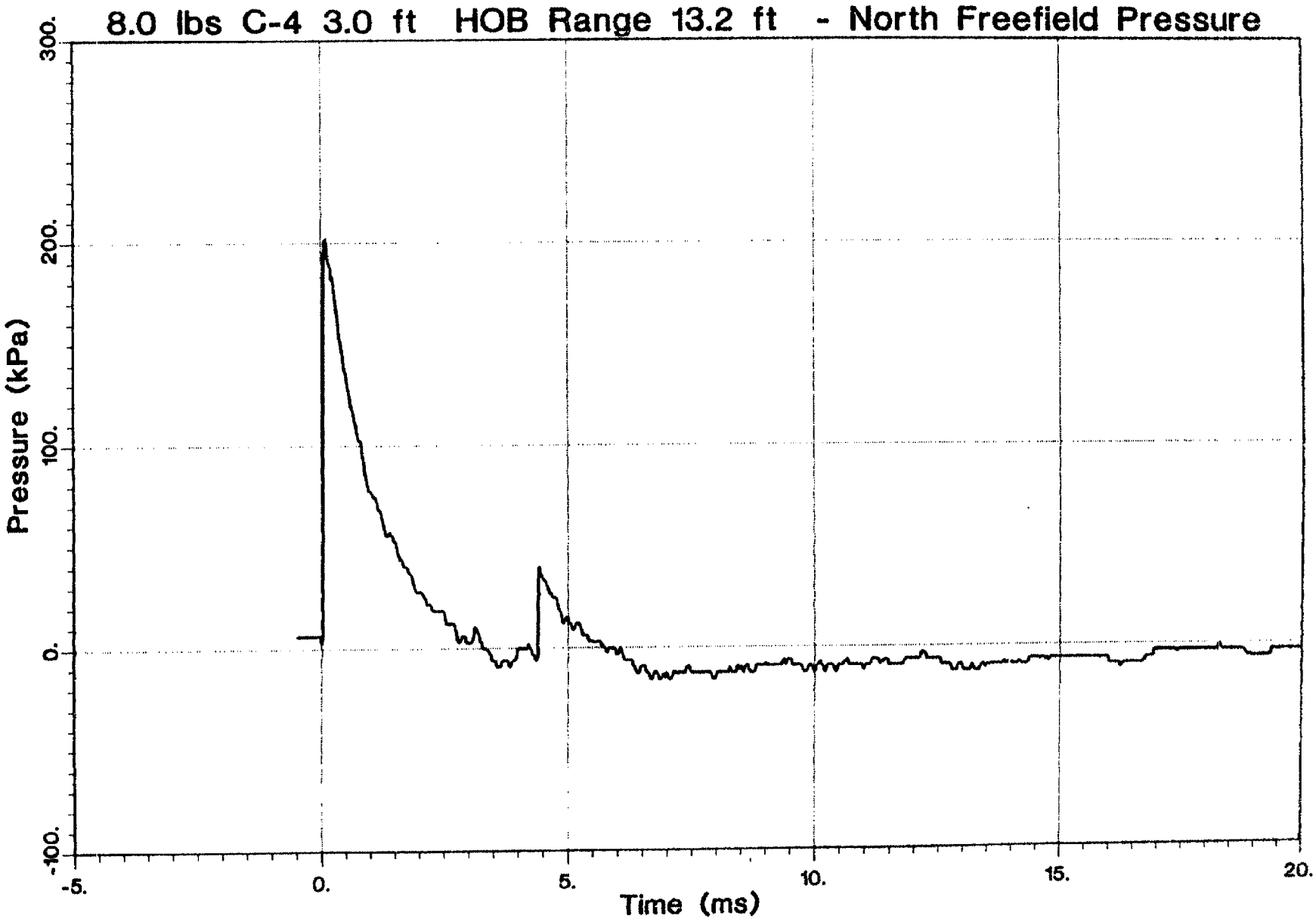
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP6A7 000 North Freefield Pressure
13:18:12.66 7-09-1986 Device 3 Channel 2 Shot 29
8.0 lbs C-4 3.0 ft HOB, 13.2 ft Range



Blast Overpressure Field Data
Case SS86C6
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	1.83 m
Distance	9.15 m
Charge wt.	29.09 kgm
Charge type	TNT

Blast Parameters:

Maximum Pressure	163.8	kpa
Positive duration (Ta)	8.9	ms
Positive Impulse (Ia)	412.6	kpa ms
Total Impulse (It)	461.6	kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic

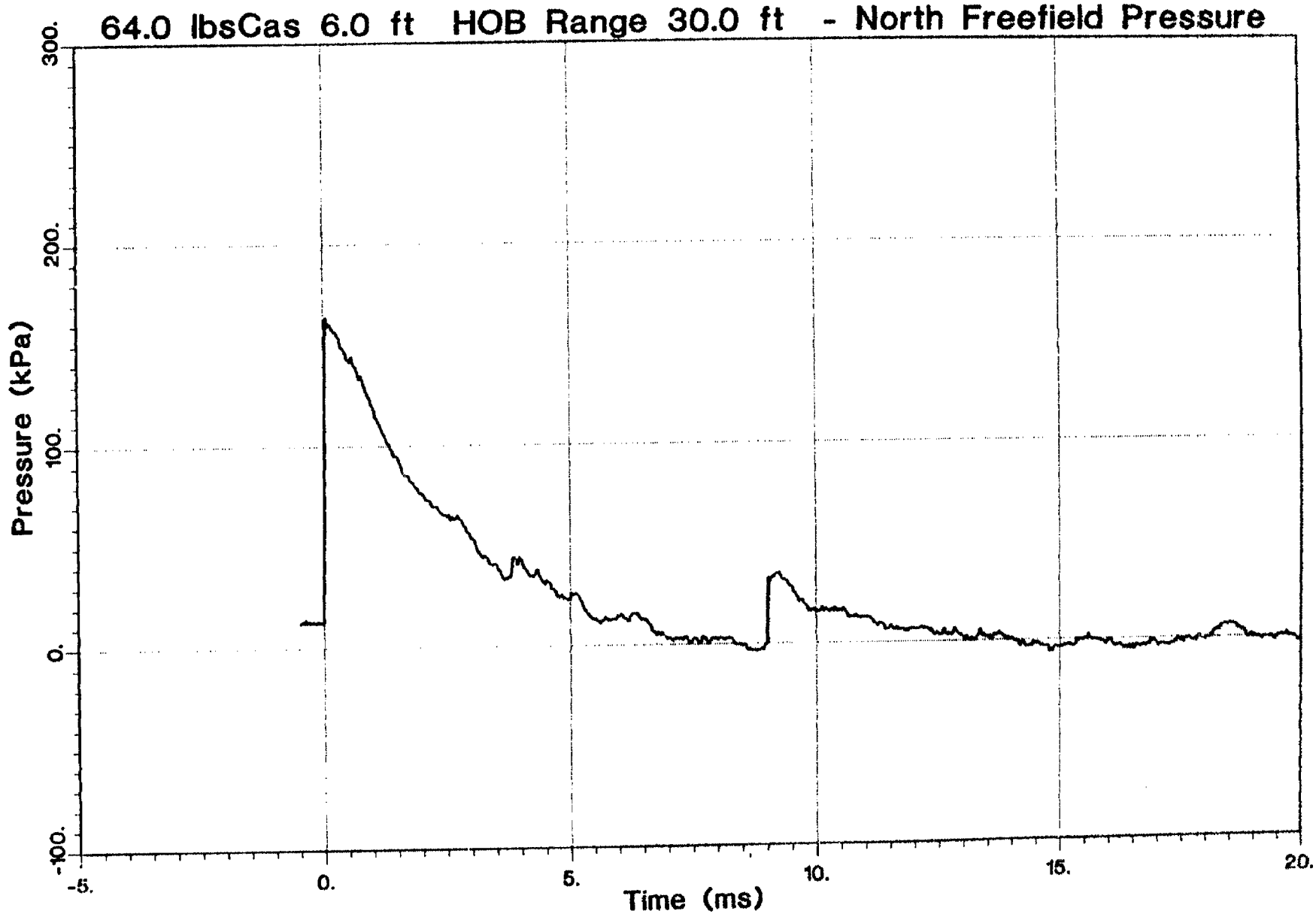
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP9A10C001 North Freefield Pressure
14:53:34.75 7-15-1986 Device 1 Channel 2 Shot 30
64.0 lbsCast TNT 6.0 ft HOB, 30.0 ft Range



Blast Overpressure Field Data
Case SS86C7
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.61 m
Distance	2.44 m
Charge wt.	3.632 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	702.8	kpa
Positive duration (Ta)	2.0	ms
Positive Impulse (Ia)	295.4	kpa ms
Total Impulse (It)	39.6	kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic

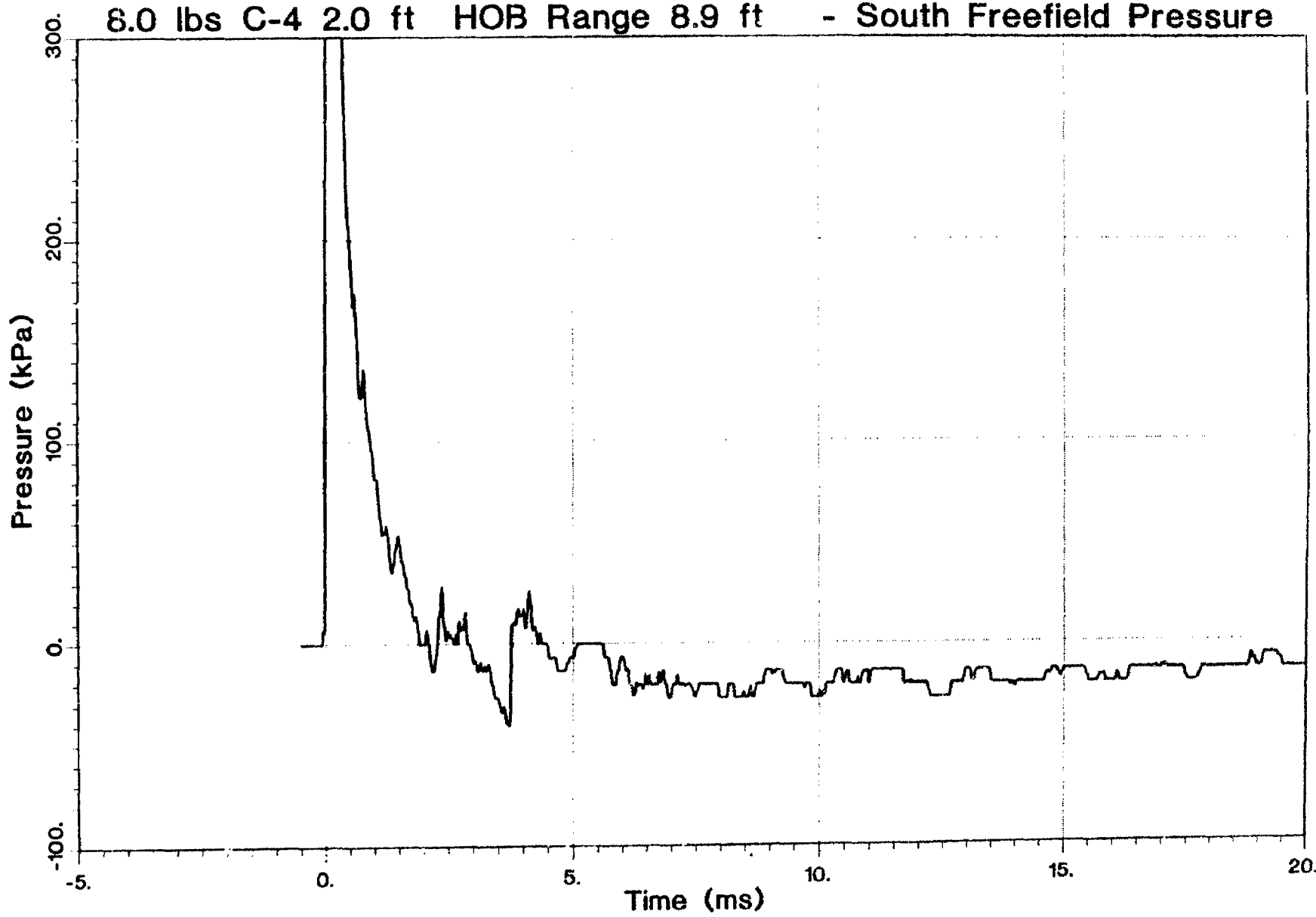
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

TPP12A13000 South Freefield Pressure
14:59:15.67 7-24-1986 Device 3 Channel 1 Shot 31
8.0 lbs C-4 Sphe 2.0 ft HOB, 8.9 ft Range



Blast Overpressure Field Data
Case SS87C2
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.91 m
Distance	3.26 m
Charge wt.	1.362 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	152.0 kpa
Positive duration (Ta)	2.7 ms
Positive Impulse (Ia)	121.6 kpa ms
Total Impulse (It)	

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic

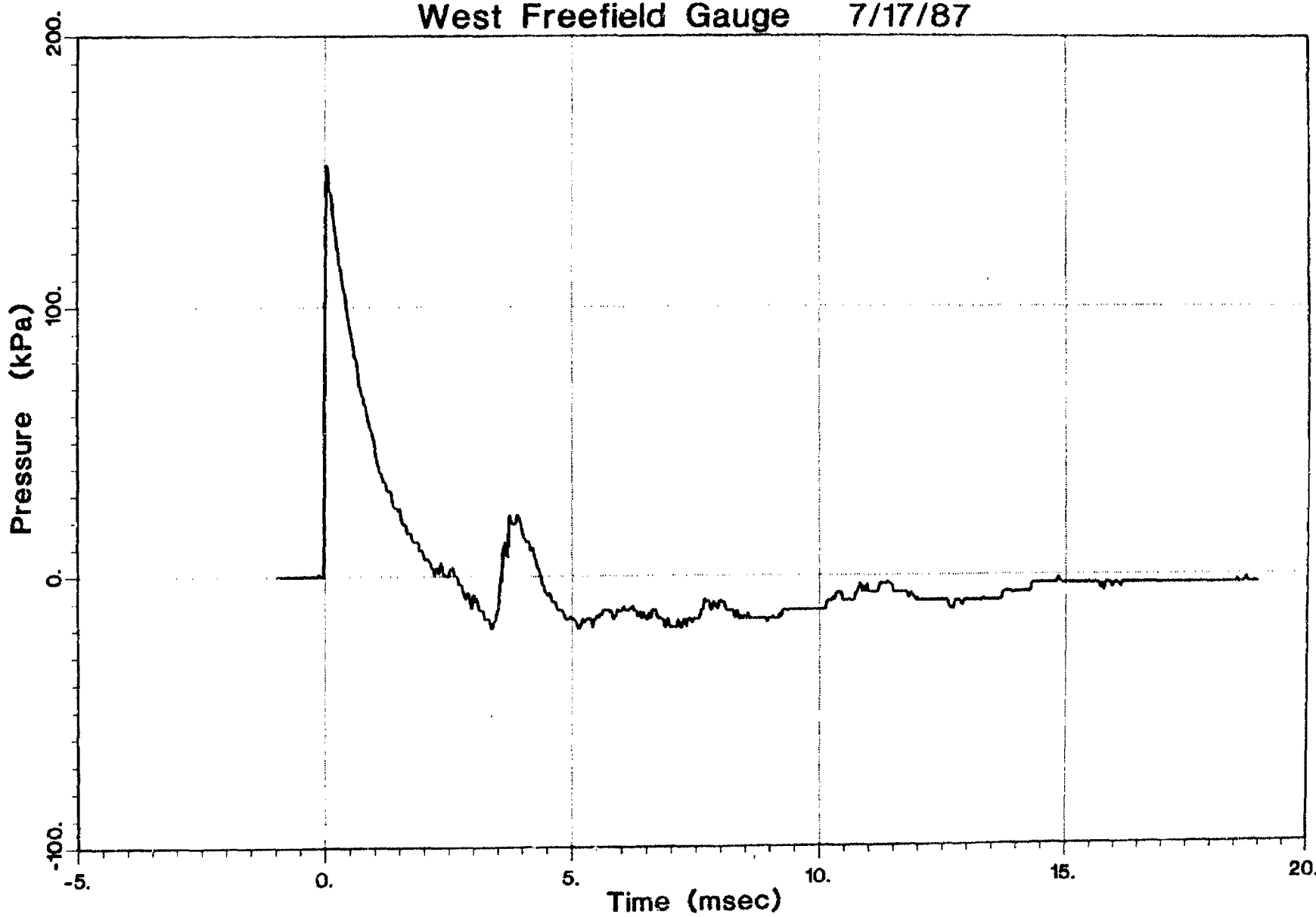
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

7-17-87 000 West Freefield Gauge ST-7-614
11: 0:22:29 7/17/1987 Device 3 Channel 1 Shot 11
3.0 lb C-4 3.0 ft HOB, 10.7 ft Range



Blast Overpressure Field Data
Case SS87C3
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.24 m
Distance	1.71 m
Charge wt.	0.454 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	300.7	kpa
Positive duration (Ta)	1.2	ms
Positive Impulse (Ia)	96.5	kpa ms
Total Impulse (It)	-27.0	kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic

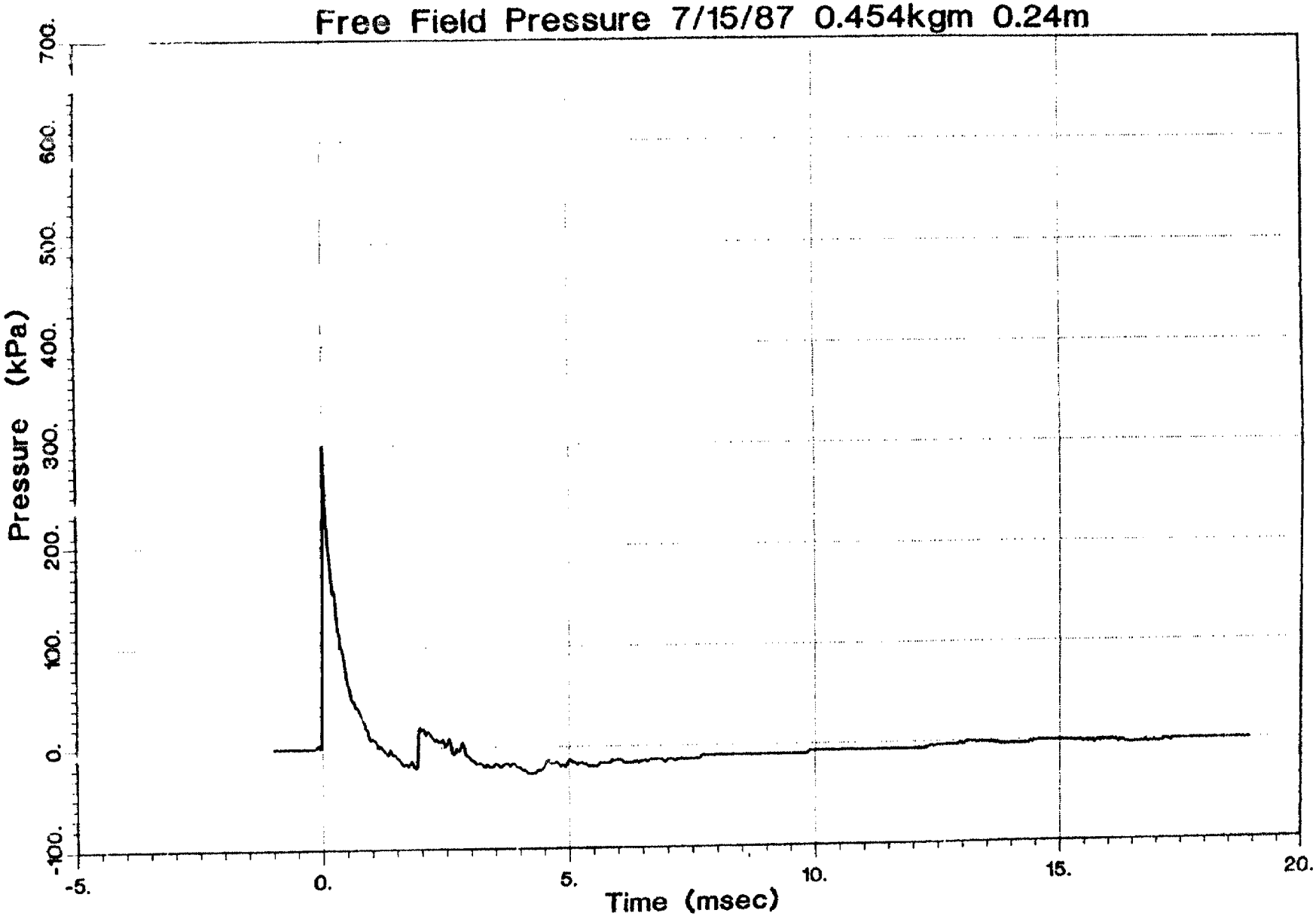
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K O'Hair, Y. Phillips, and, D. Butkus.

7-15-87 000 West Freefield Gauge ST-7-614
11: 0:49:44 7/15/1987 Device 3 Channel 1 Shot 20
1.0 lb C-4 0.8 ft HOB, 5.6 ft Range



Blast Overpressure Field Data
Case SS87C4
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.305 m
Distance	1.77 m
Charge wt.	0.227 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	159.8	kpa
Positive duration (Ta)	1.44	ms
Positive Impulse (Ia)	70.8	kpa ms
Total Impulse (It)	11.4	kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic

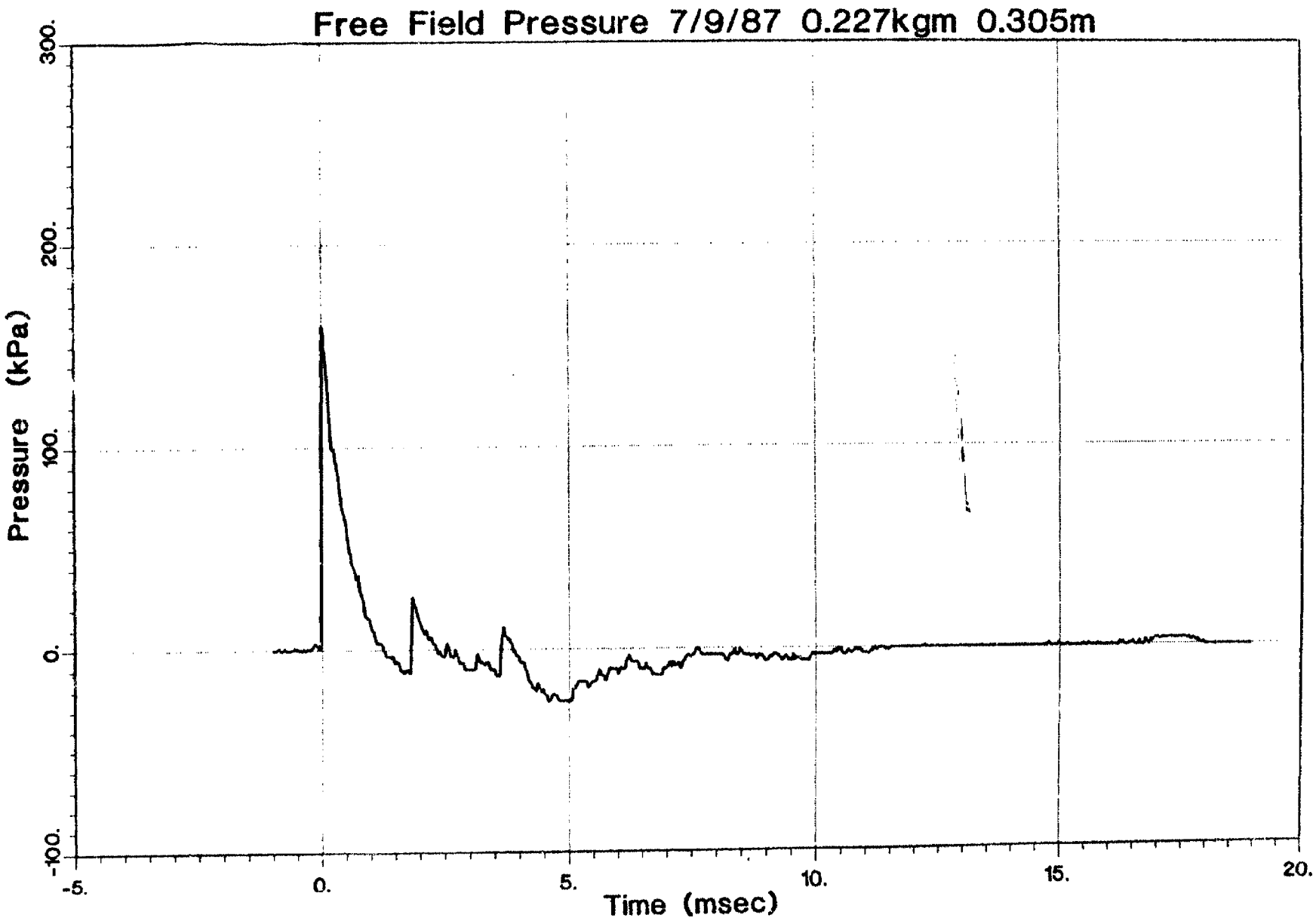
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

7-9-87 000 West Freefield Gauge ST-7-614
10: 0: 1:46 7/ 9/1987 Device 3 Channel 1 Shot 13
0.5 lb C-4 1.0 ft HOB, 5.8 ft Range



Blast Overpressure Field Data
Case SS87C7
Location Albuquerque

Blast Conditions:

Geometry	Free Field
H.O.B.	0.61 m
Distance	2.44 m
Charge wt.	3.632 kgm
Charge type	C4

Blast Parameters:

Maximum Pressure	643.6 kpa
Positive duration (Ta)	2.58 ms
Positive Impulse (Ia)	286.9 kpa ms
Total Impulse (It)	-29.8 kpa ms (20 ms)

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic

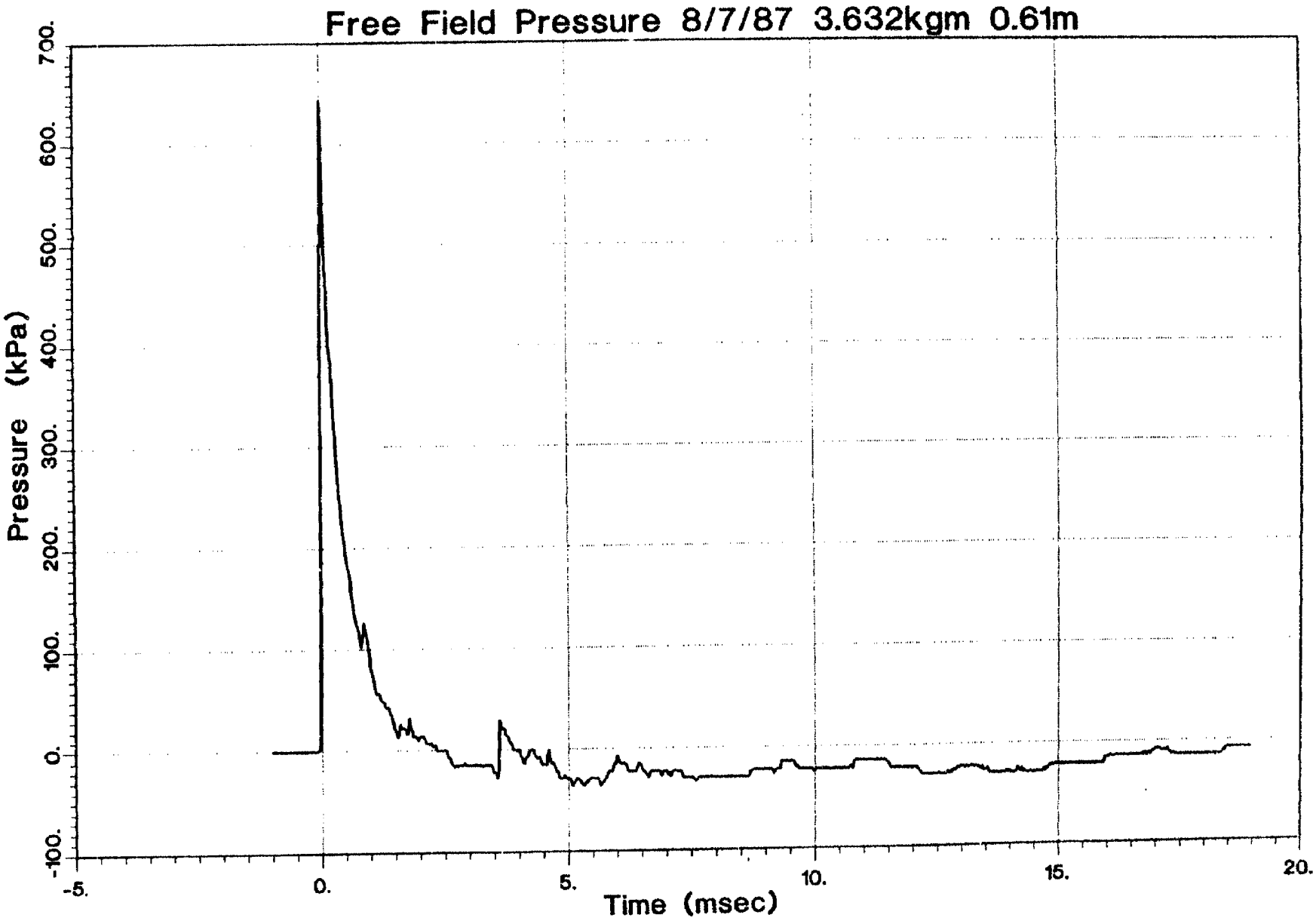
Reference:

1) Calculations of the Internal Mechanical Response of Sheep to Blast Loading ; M. Vander Vorst, K. Dodd, J. Stuhmiller, and, Y. Phillips

2) Analysis of Field Test Results of the Biophyical Response of Sheep to Blast Loading; K.Dodd, M. Vander Vorst, K. O'Hair, J. Yelverton, Y. Phillips, and, D. Richmond.

3) Biophysical Response to Air Blast Loading in a Free Field; K. Dodd, K. O'Hair, Y. Phillips, and, D. Butkus.

8-7-87 000 West Freefield Gauge 8/7/87
11: 0:56:41 8/ 7/1987 Device 2 Channel 1 Shot 16
8.0 lb C-4 2.0 ft HOB, 8.9 ft Range



DOUBLE PEAK

Blast Overpressure Field Data
Case DP0
Location Albuquerque

Blast Conditions:

Geometry	Double Peak two simultaneous blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters: No Data
- Maximum Pressure
- Positive duration (Ta)
- Positive Impulse (Ia)
- Total Impulse (It)

	Shot:				Data Collection:
Animal ID	Injury Grade	Time	Date	Ref #	Ps Skin Lamb Esoph Plral Adom Vic
7	E		3/10/81	1	
8	E		3/10/81	1	
9	E		3/13/81	1	
10	E		3/13/81	1	
11	E		3/17/81	1	
12	E		3/17/81	1	

Reference:

1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

Blast Overpressure Field Data
Case DP1.7
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 1.7 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters:	South	North
Maximum Pressure	356.7 kPa	267.8 kPa
Positive duration (Ta)	1.16 ms	1.68 ms
Positive Impulse (Ia)	124.6 kPa ms	180.1 kPa ms
Total Impulse (It)	151.13 kPa ms (10ms)	218.2 kpa ms

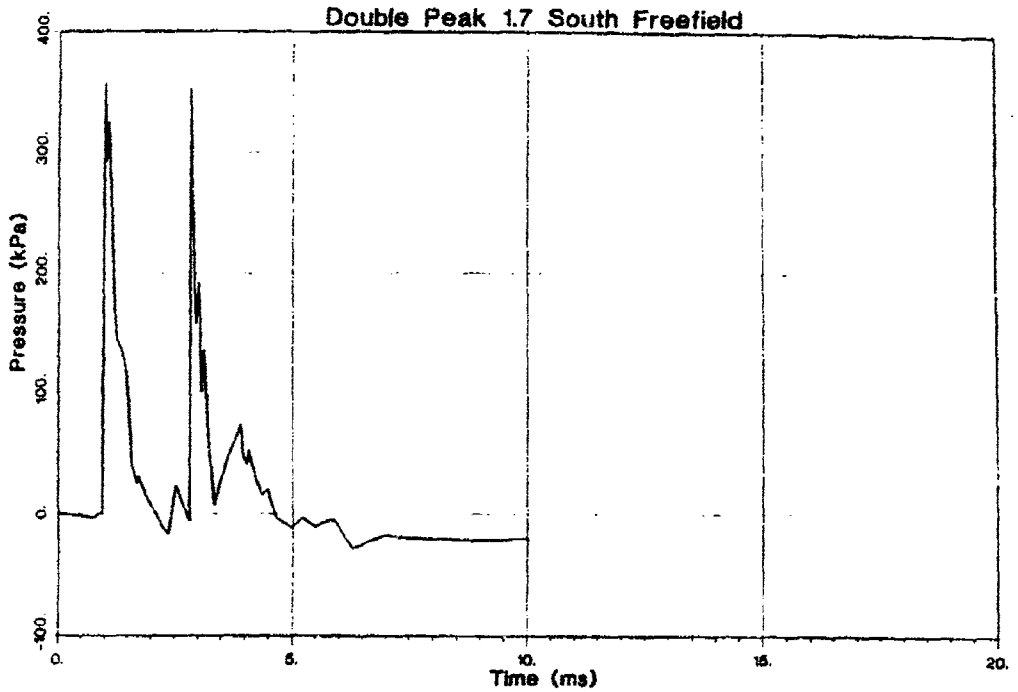
Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref *	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
2	M		10/28/81	1	Y		Y				Y

Reference:

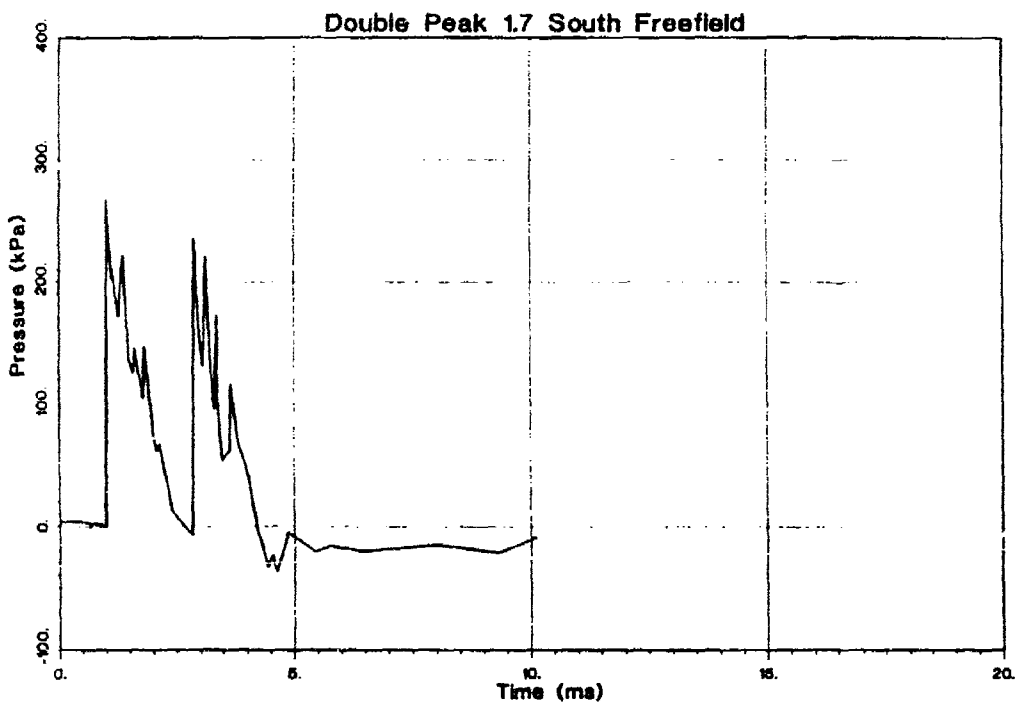
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DPS17 Double peak 1.7 ms blast seperation south se
3/10/81 Device 1 Channel 1 Shot 37
8 TNT 1 HOB, 11 Range



DPN17 Double peak 1.7 ms blast seperation north se
3/10/81 Device 1 Channel 1 Shot 38
8 TNT 1 HOB, 11 Range



Blast Overpressure Field Data
Case DP3.6
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 3.6 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters:	South	North
Maximum Pressure	349.2 kPa	259.8 kPa
Positive duration (Ta)	1.1 ms	1.5 ms
Positive Impulse (Ia)	94.8 kPa ms	142.4 kPa ms
Total Impulse (It)	212.1 kPa ms (9.8ms)	113.7 kpa ms

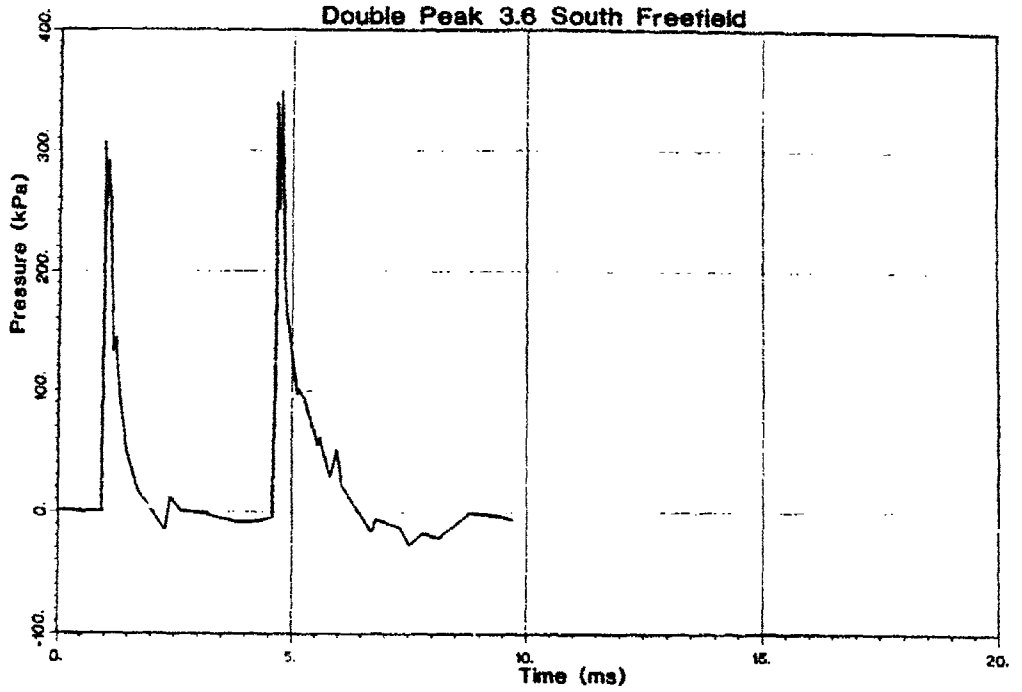
Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
1	M		10/28/81	1	Y		Y				Y

Reference:

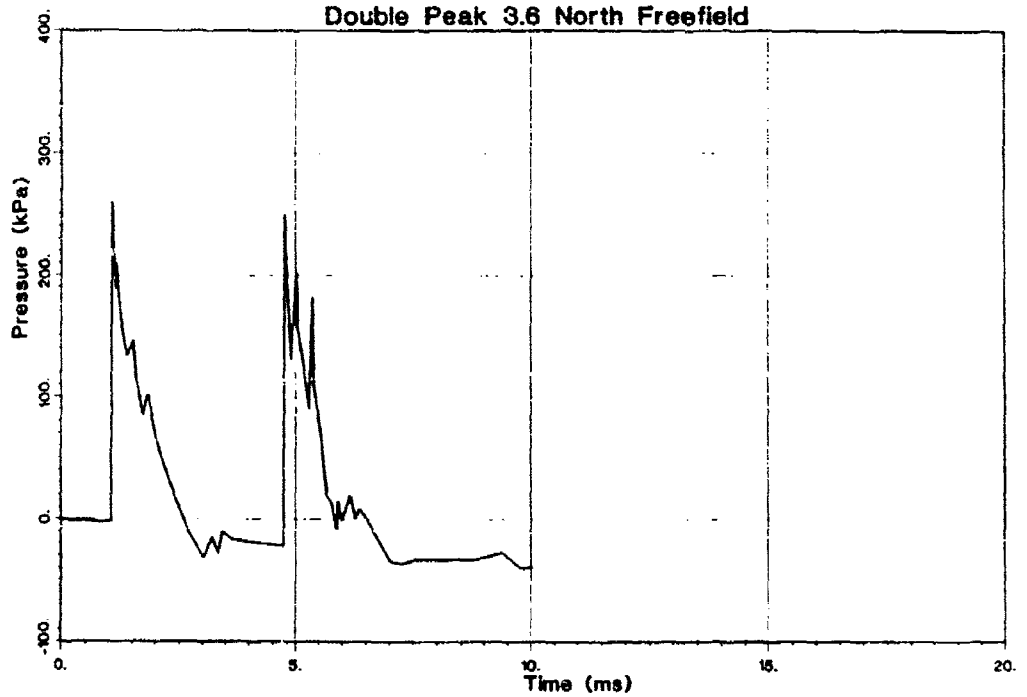
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DPS36 Double peak 3.6 ms blast seperation south se
10/28/81 Device 1 Channel 1 Shot 40
8 TNT 1 HOB, 11 Range



DPN36 Double peak 3.6 ms blast seperation north se
10/28/81 Device 1 Channel 1 Shot 39
8 TNT 1 HOB, 11 Range



Blast Overpressure Field Data
Case DP5.5
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 5.5 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters:	South	North
Maximum Pressure	385.5 kPa	291.7 kPa
Positive duration (Ta)	1.04 ms	1.6 ms
Positive Impulse (Ia)	115.8 kPa ms	163.6 kPa ms
Total Impulse (It)	206.9 kpa ms (9.9ms)	235.8 kPa ms

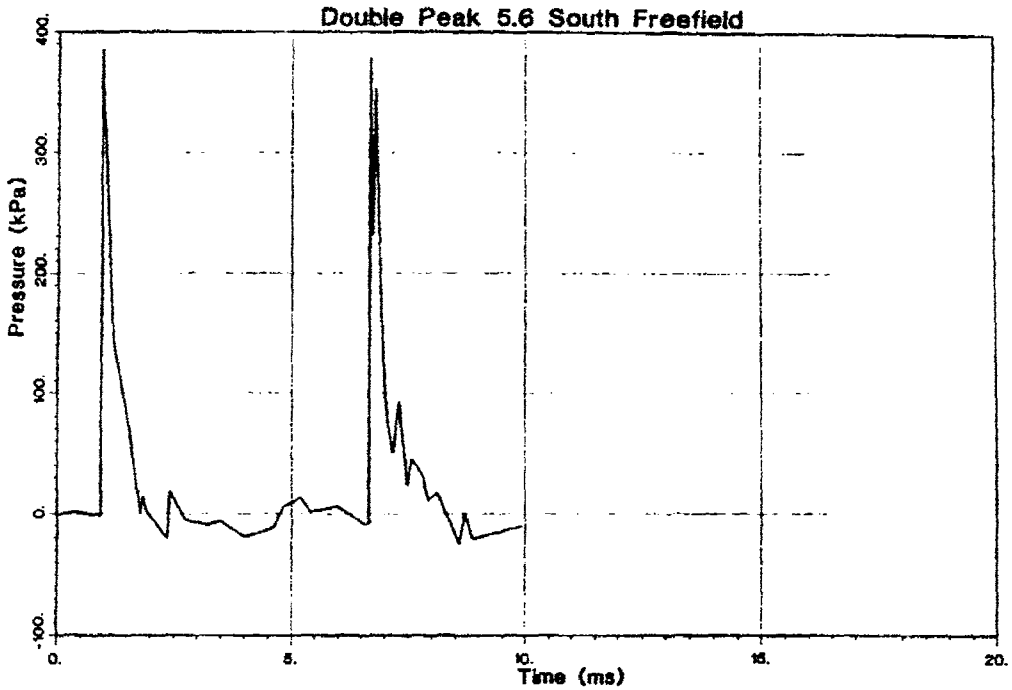
Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
3	M		10/27/81	1	Y		Y				Y

Reference:

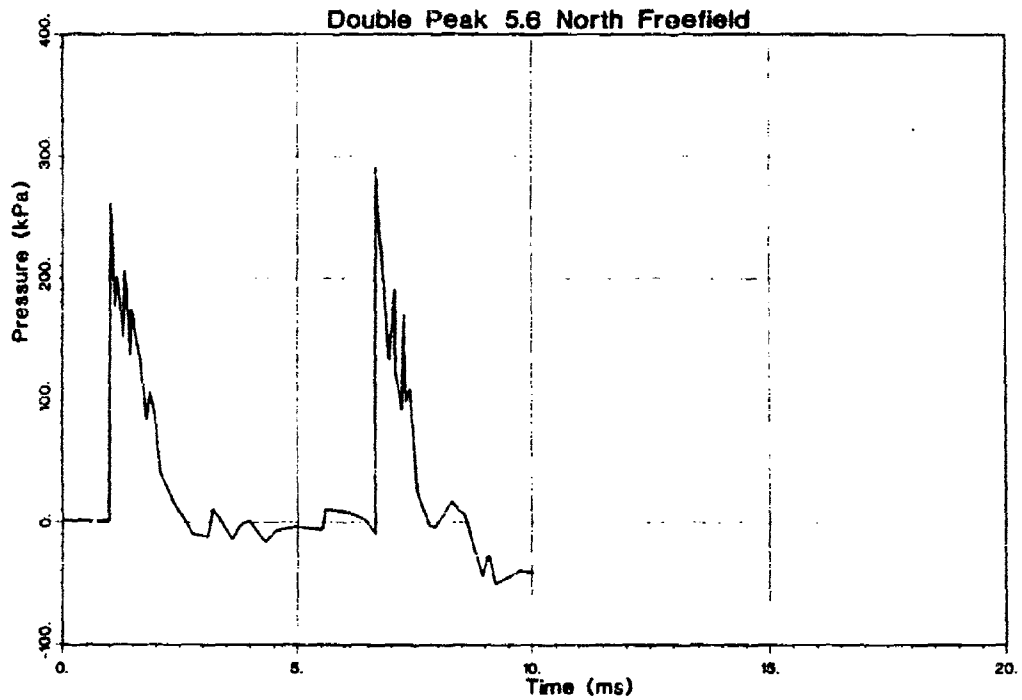
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DPS56 Double peak 5.6 ms blast seperation south se
10/27/81 Device 1 Channel 1 Shot 41
8 TNT 1 HOB, 11 Range



DPN56 Double peak 5.6 ms blast seperation north se
10/27/81 Device 1 Channel 1 Shot 42
8 TNT 1 HOB, 11 Range



Blast Overpressure Field Data
Case DP7.5
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 7.5 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters:	South	North
Maximum Pressure	425.5 kPa	344.5 kPa
Positive duration (Ta)	1.1 ms	1.5 ms
Positive Impulse (Ia)	136.8 kPa ms	193.8 kPa ms
Total Impulse (It)	142.0 kPa ms (12ms)	187.3 kPa ms

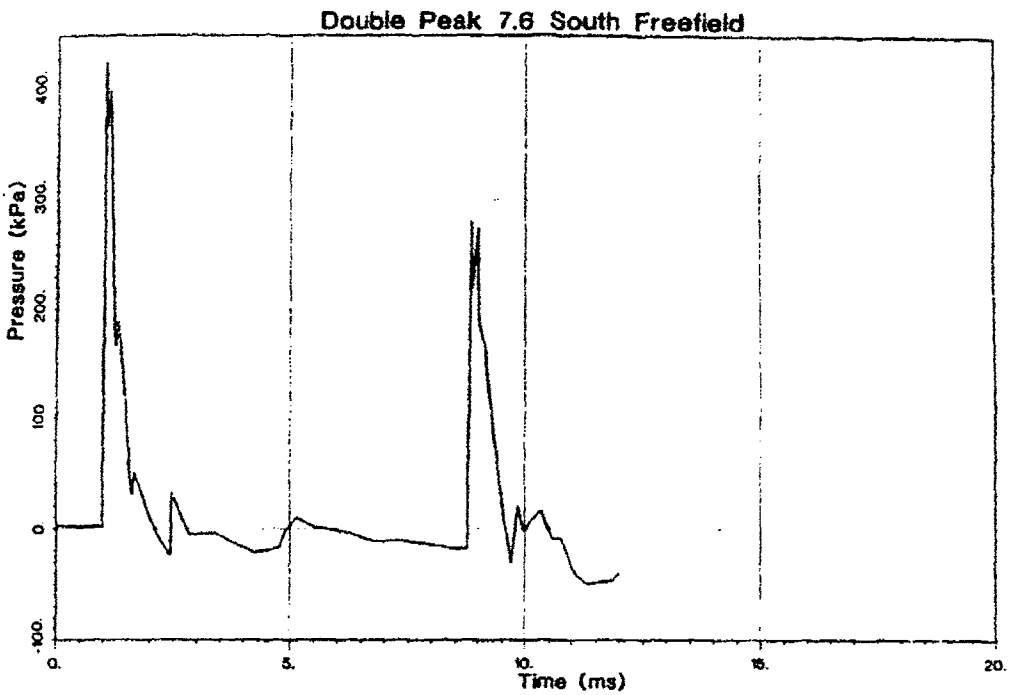
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom Vic
2	M		10/27/81	1	Y		Y			Y

Reference:

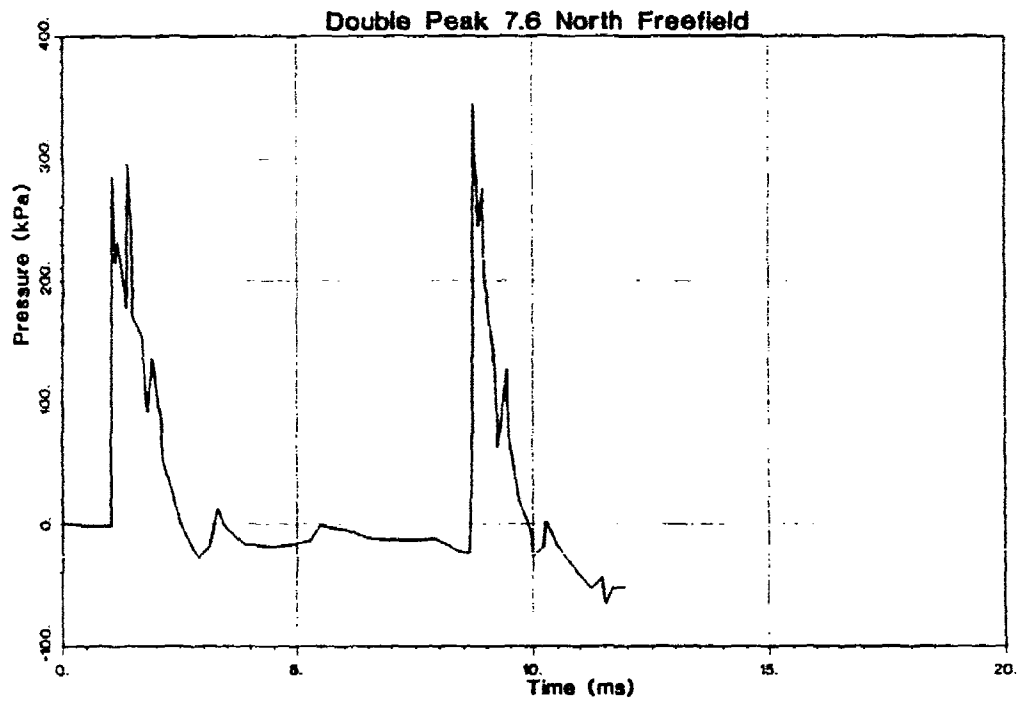
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DPS76 Double peak 5.6 ms blast seperation south se
10/27/81 Device 1 Channel 1 Shot 43
8 TNT 1 HOB. 11 Range



DPN76 Double peak 7.6 ms blast seperation north se
10/27/81 Device 1 Channel 1 Shot 44
8 TNT 1 HOB. 11 Range



Blast Overpressure Field Data
Case DP9.7
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 9.7 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters: No Data
- Maximum Pressure
- Positive duration (Ta)
- Positive Impulse (Ia)
- Total Impulse (It)

	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Ski-	Lamb	Esoph	Plral	Adom	Vic
13	M		3/25/81	1							
14	M		3/25/81	1							

Reference:

1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

Blast Overpressure Field Data
Case DP11.6
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 11.6 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters:	South	North
Maximum Pressure	376.4 kPa	367.9 kPa
Positive duration (Ta)	1.1 ms	1.5 ms
Positive Impulse (Ia)	128.0 kPa ms	154.6 kPa ms
Total Impulse (It)		

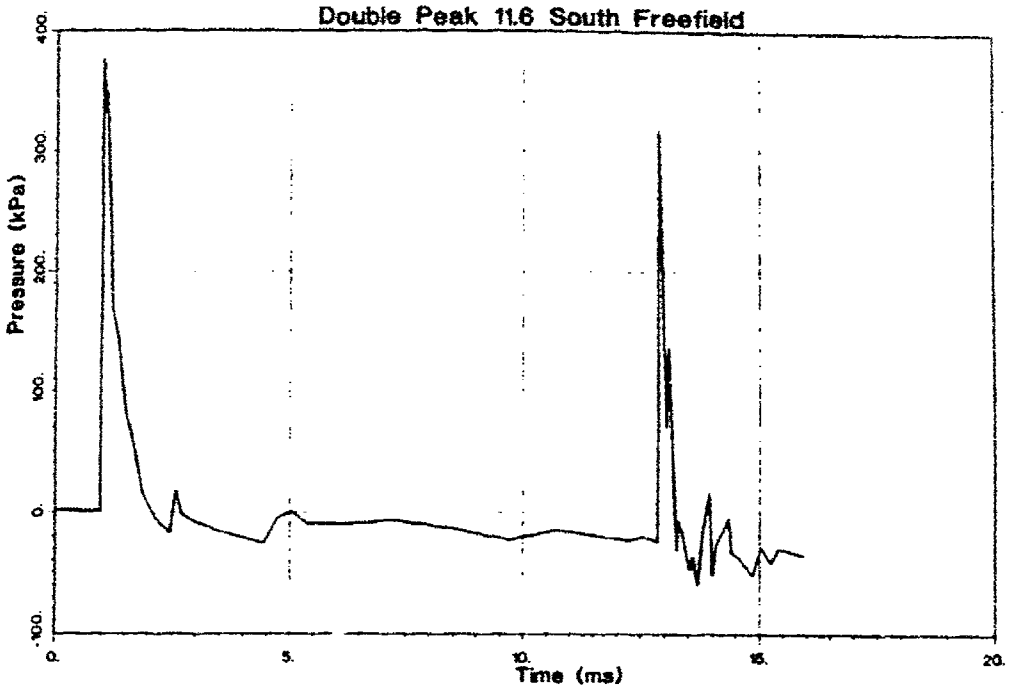
Shot:					Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
1	M		10/27/81	1	Y		Y				Y

Reference:

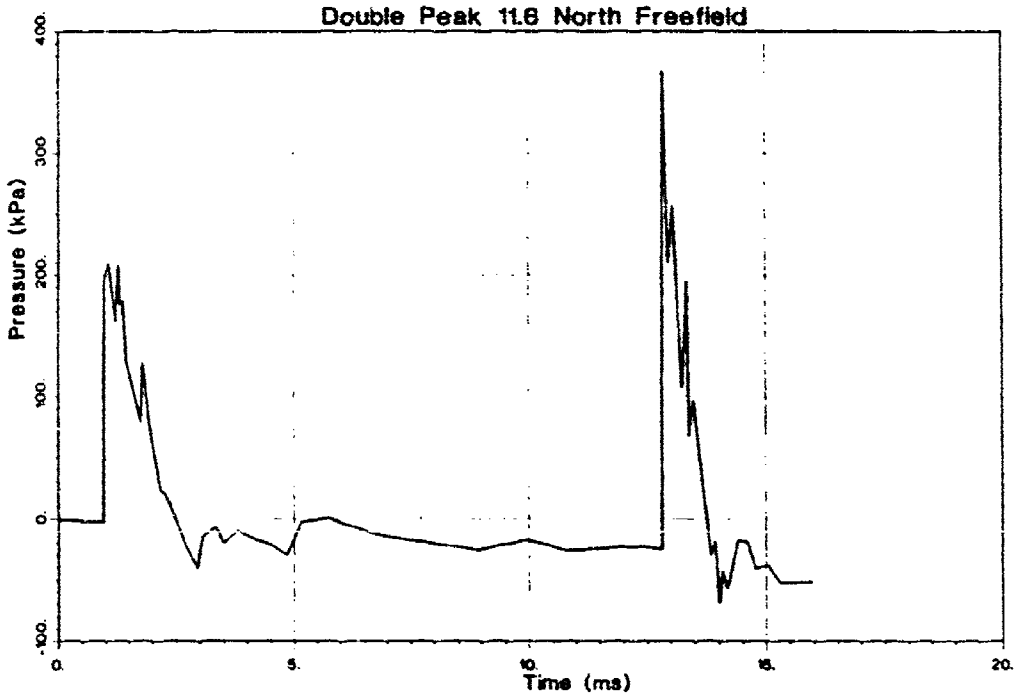
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stummiller; February 22, 1987.

DPS116 South
10/27/81 Device 1 Channel 1 Shot 45
6 TNT 1 HOB, 11 Range



DPN116 Double peak 11.6 ms blast seperation north s
10/27/81 Device 1 Channel 1 Shot 46
6 TNT 1 HOB, 11 Range



Blast Overpressure Field Data
Case DP13.6
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 13.6 sec. between blast
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters:	South	North
Maximum Pressure	354.5 kPa	322.9 kPa ms
Positive duration (Ta)	1.2 ms	1.5 ms
Positive Impulse (Ia)	134.7 kPa ms	179.5 kPa ms
Total Impulse (It)	49.8 kPa ms (12ms)	130.1 kPa ms

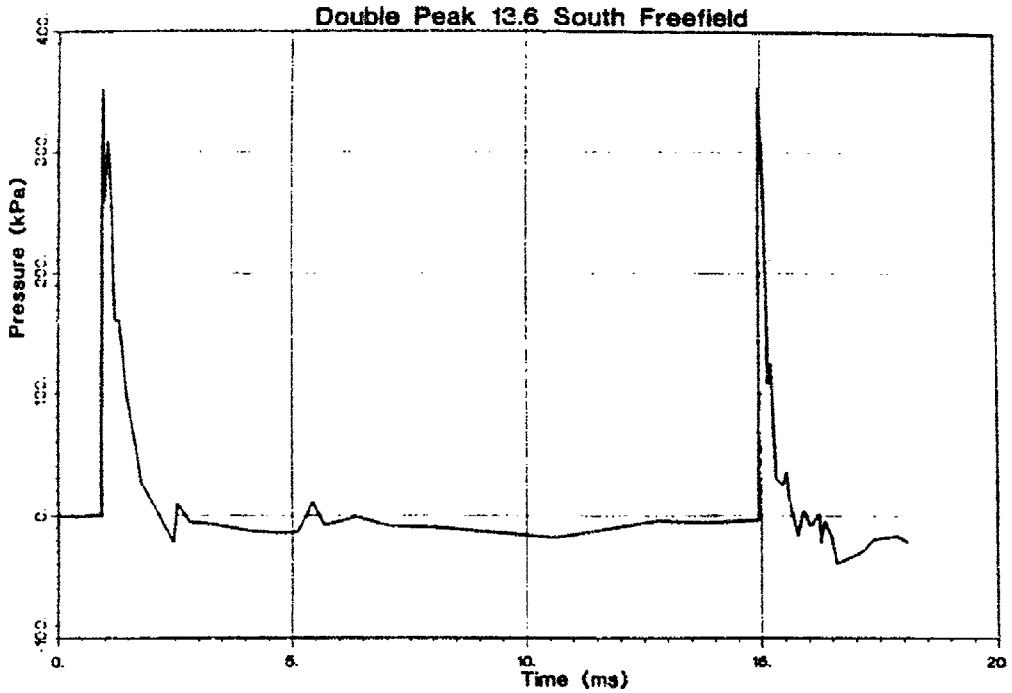
	Shot:				Data Collection:					
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
1	M		10/26/81	1	Y		Y				Y

Reference:

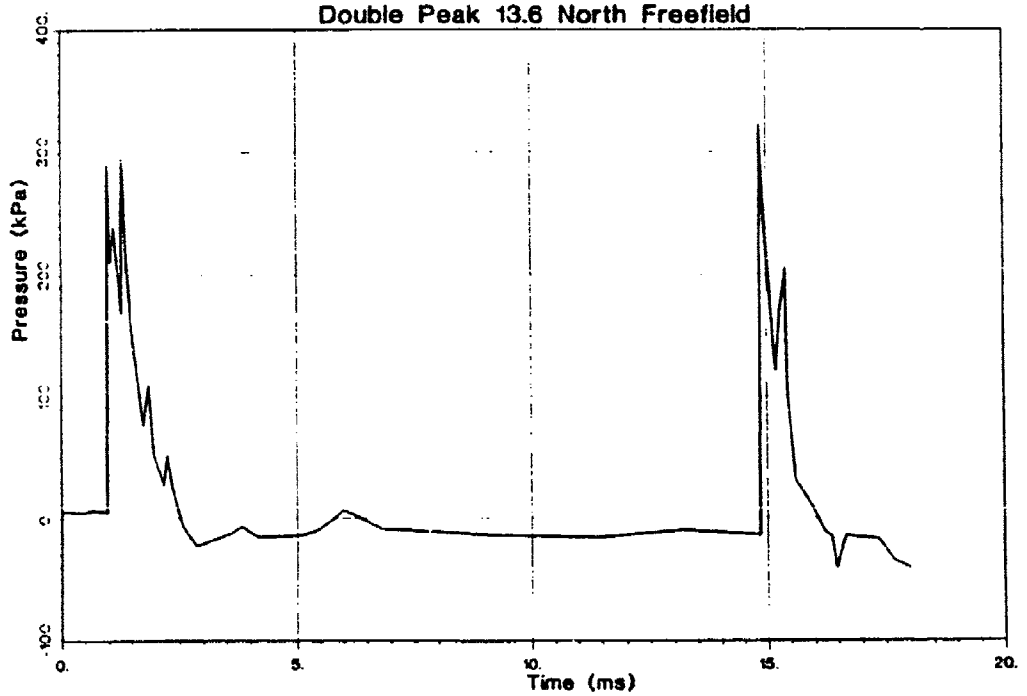
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DPS136 Double peak 13.6 ms blast seperation south s
10/26/81 Device 1 Channel 1 Shot 47
8 TNT 1 HOB. 11 Range



DPN136 Double peak 13.6 ms blast seperation north s
10/26/81 Device 1 Channel 1 Shot 48
8 TNT 1 HOB. 11 Range



Blast Overpressure Field Data
Case DPS
Location Albuquerque

Blast Conditions:

Geometry	Double Peak single shot
H.O.B.	0.305 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	TNT

Blast Parameters: No Data
- Maximum Pressure
- Positive duration (Ta)
- Positive Impulse (Ia)
- Total Impulse (It)

	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
5	M		3/10/81	1							
6	M		3/10/81	1							

Reference:

1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

Blast Overpressure Field Data
Case DP3.8-PEN
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 3.8 sec between blast
H.O.B.	0.457 m
Distance	3.05 m
Charge wt.	3.632 kgm
Charge type	Pentolite

Blast Parameters:	West	East
Maximum Pressure	519.0 kPa	607.9 kPa
Positive duration (Ta)	1.25 ms	1.4 ms
Positive Impulse (Ia)	192.8 kPa ms	239.5 kPa ms
Total Impulse (It)	288.4 kPa ms (9.9ms)	420.6 kPa ms

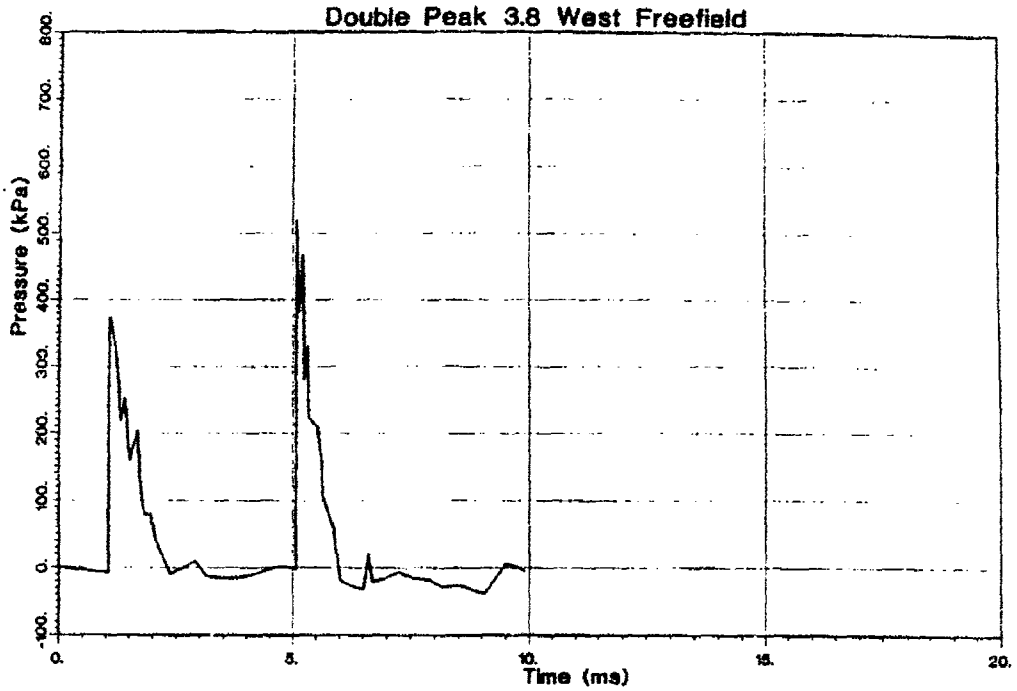
Animal ID	Injury Grade	Shot: Time	Date	Ref #	Data Collection: Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
2	E		5/13/82	1	Y			Y			
1	E		5/13/82	1							

Reference:

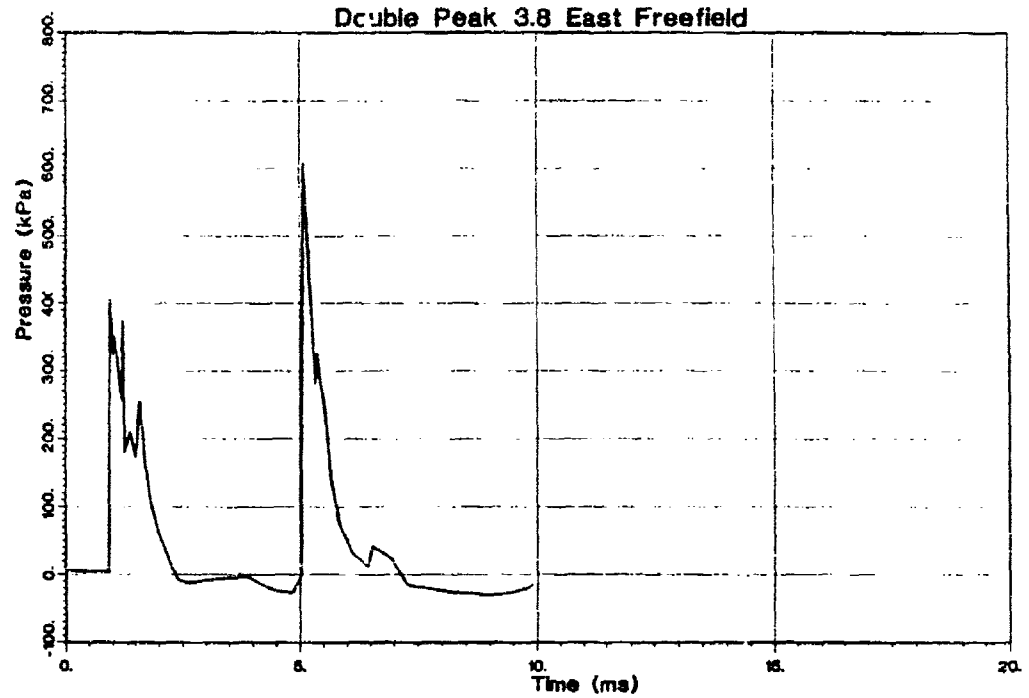
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DP38PW Double peak 3.8 ms blast seperation west sen
5/13/82 Device 1 Channel 1 Shot 49
8 TNT 1 HOB, 11 Range



DP38PE Double peak 3.8 ms blast seperation east sen
5/13/82 Device 1 Channel 1 Shot 50
8 TNT 1 HOB, 11 Range



Blast Overpressure Field Data
Case DP9.6-PEN
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 9.6 sec between blast
H.O.B.	0.457 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	Pentolite

Blast Parameters:

Maximum Pressure	403.2 kPa
Positive duration (Ta)	1.2 ms
Positive Impulse (Ia)	161.3 kPa ms
Total Impulse (It)	145.9 ms (14.9ms)

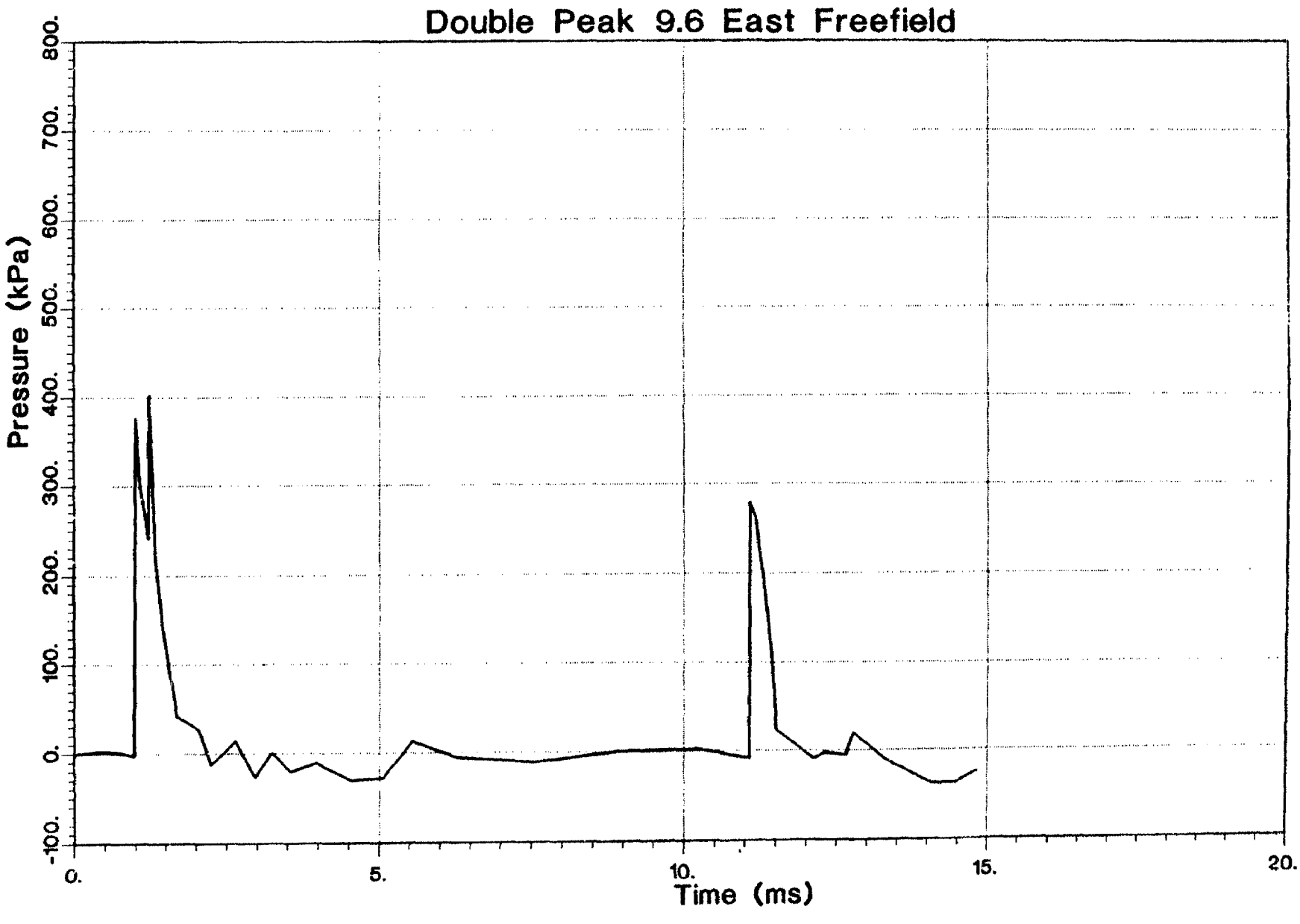
	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
2	E		5/17/82	1	Y			Y			
1	E		5/17/82	1							
2	E		5/21/82	1							
1	M		5/21/82	1							

Reference:

1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DP96PE Double peak 9.6 blast seperation east sensor
5/17/82 Device 1 Channel 1 Shot 55
8 Pentolite 1 HOB, 11 Range



Blast Overpressure Field Data
Case DP9.7-PEN
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 9.7 sec between blast
H.O.B.	0.457 m
Distance	3.2 m
Charge wt.	3.632 kgm
Charge type	Pentolite

Blast Parameters:

Maximum Pressure	533.0 kPa
Positive duration (Ta)	1.25 ms
Positive Impulse (Ia)	175.5 kPa ms
Total Impulse (It)	412.8 kPa ms (15ms)

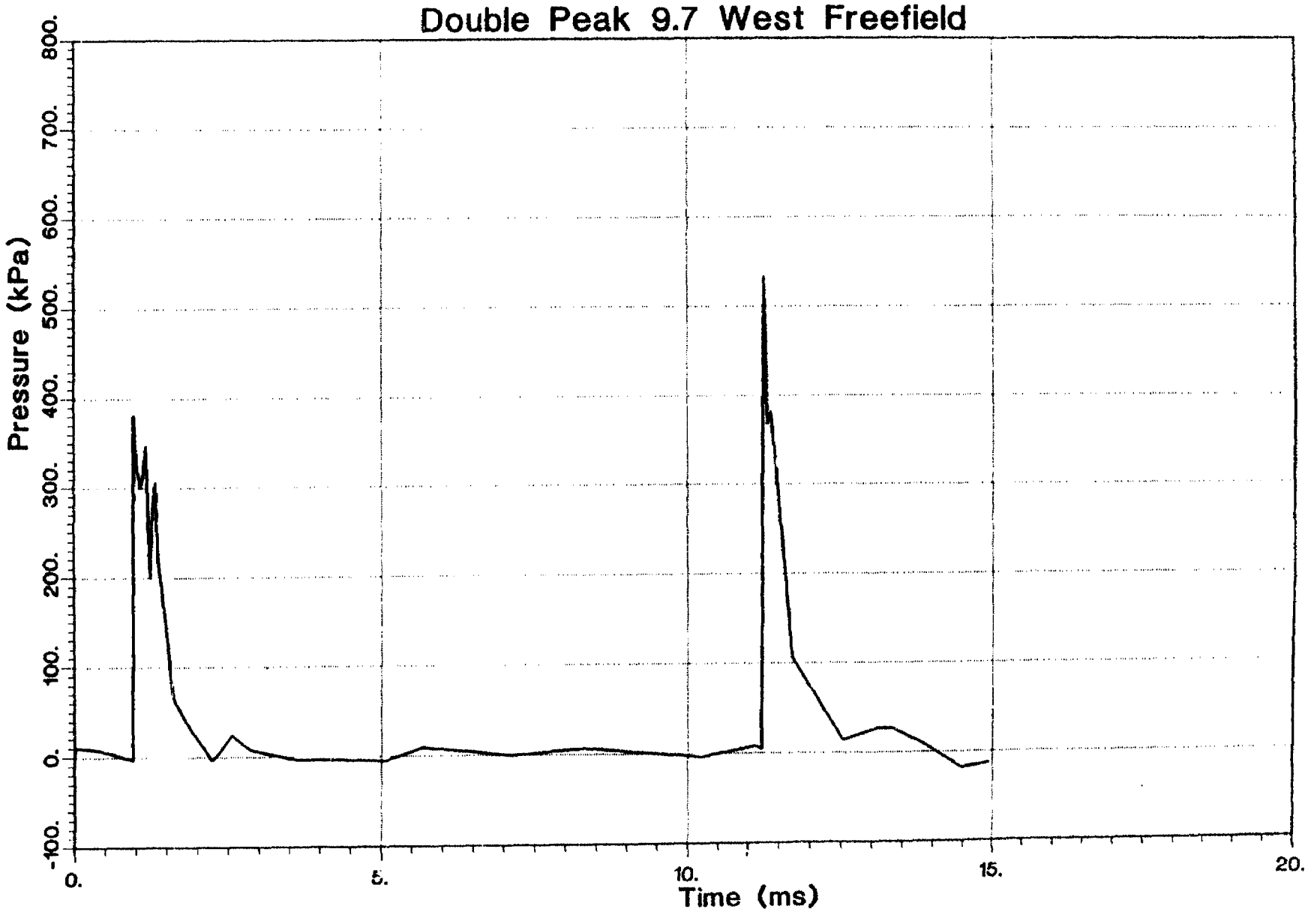
Animal ID	Shot: Injury Grade	Time	Date	Ref #	Data Collection: Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
2	E		5/14/82	1	Y			Y			
1	E		5/14/82	1							

Reference:

1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DP97PW Double peak 9.7 ms blast seperation west sen
5/14/82 Device 1 Channel 1 Shot 53
8 Pentolite HOB, 11 Range



Blast Overpressure Field Data
Case DP9.9-PEN
Location Albuquerque

Blast Conditions:

Geometry	Double Peak 9.9 & 9.8 sec between blast
H.O.B.	0.457 m
Distance	3.05 m
Charge wt.	3.632 kgm
Charge type	Pentolite

Blast Parameters:	9.9	9.8
Maximum Pressure	632.0 kPa	547.4 kPa ms
Positive duration (Ta)	1.4 ms	1.6 ms
Positive Impulse (Ia)	207.7 kPa ms	210.6 kPa ms
Total Impulse (It)	346.6 kPa ms (14.9ms)	245.6 kPa ms

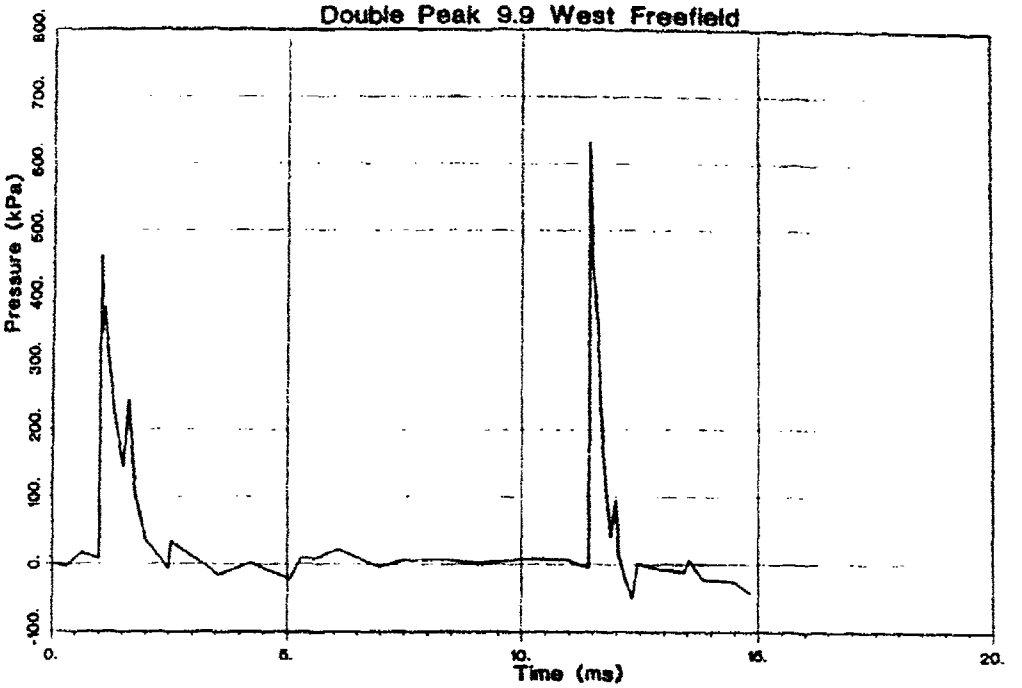
Animal ID	Shot: Injury Grade	Time	Date	Ref #	Data Collection: Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
2	E		5/11/82	1	Y			Y			
1	E		5/11/82	1							

Reference:

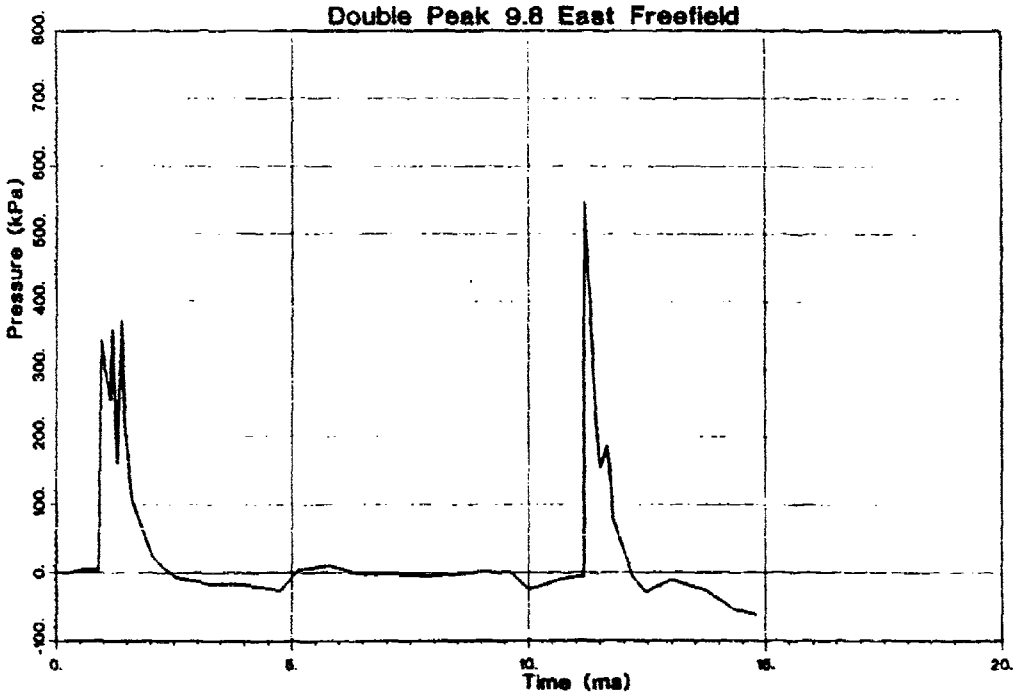
1) Double Peak Study Results Report; D. Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DP98PW Double peak 9.9 blast seperation west sensor
5/11/82 Device 1 Channel 1 Shot 51
8 Pentolite HOB, 11 Range



DP98PE Double peak 9.8 blast seperation east sensor
5/11/82 Device 1 Channel 1 Shot 52
8 Pentolite 1 HOB, 11 Range



Blast Overpressure Field Data
Case DPS-PEN
Location Albuquerque

Blast Conditions:

Geometry	Double Peak single shot
H.O.B.	0.457 m
Distance	3.35 m
Charge wt.	3.632 kgm
Charge type	Pentolite

Blast Parameters:	West	East
Maximum Pressure	436.0 kPa	352.7 kPa
Positive duration (Ta)	1.9 ms	1.55 ms
Positive Impulse (Ia)	218.2 kPa ms	185.2 kPa ms
Total Impulse (It)	293.5 kPa ms (9.8ms)	183.4 kPa ms

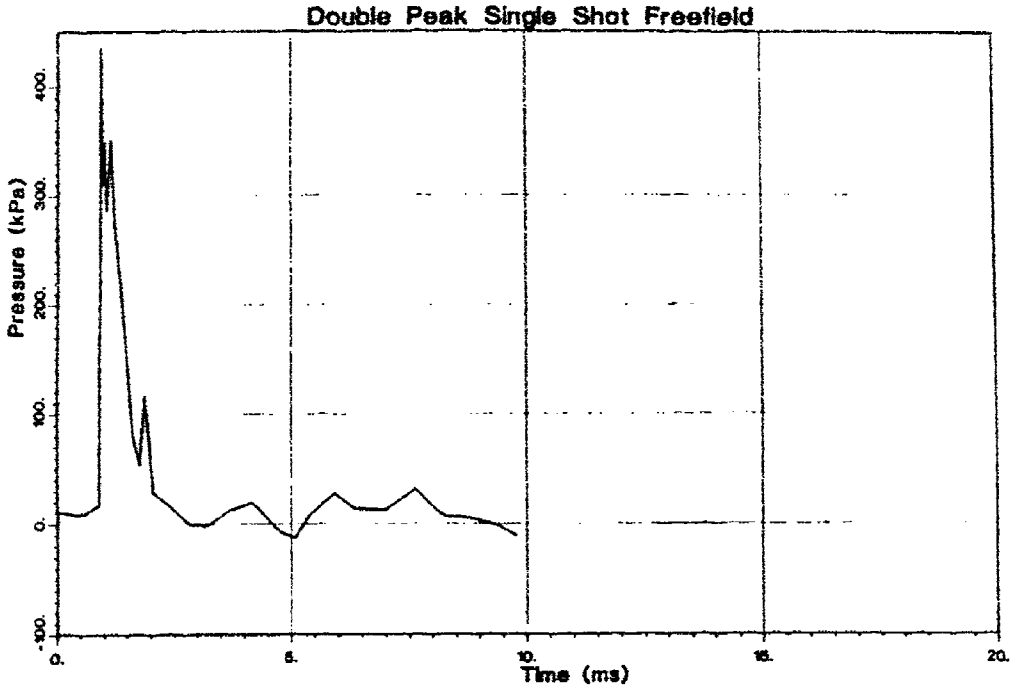
	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
2	M		5/18/82	1	Y			Y			
1	E		5/18/82	1							

Reference:

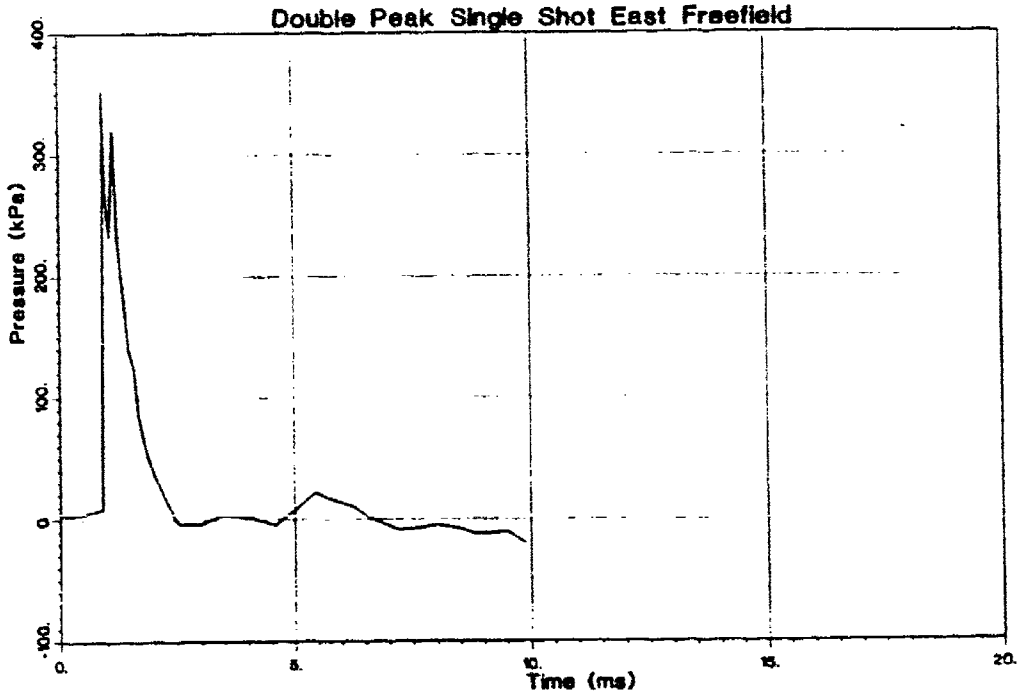
1) Double Peak Study Results Report; D Richmond and Staff of ITRI Biodynamics Laboratory; June 18, 1982.

2) Calculation of Parenchymal Pressure Due to Double Peak Loading; M. Vander Vorst and J. Stuhmiller; February 22, 1987.

DPSPW Double peak single shot west sensor
5/18/82 Device 1 Channel 1 Shot 56
8 Pentolite HOB, 11 Range



DPSPE Double peak single shot east sensor
5/18/82 Device 1 Channel 1 Shot 57
8 Pentolite 1 HOB, 11 Range



ISO-IMPULSE

Blast Overpressure Field Data
Case ISO1
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.457 m
Distance	2.29 m
Charge wt.	0.454 kgm
Charge type	Pentolite Sphere

Blast Parameters:

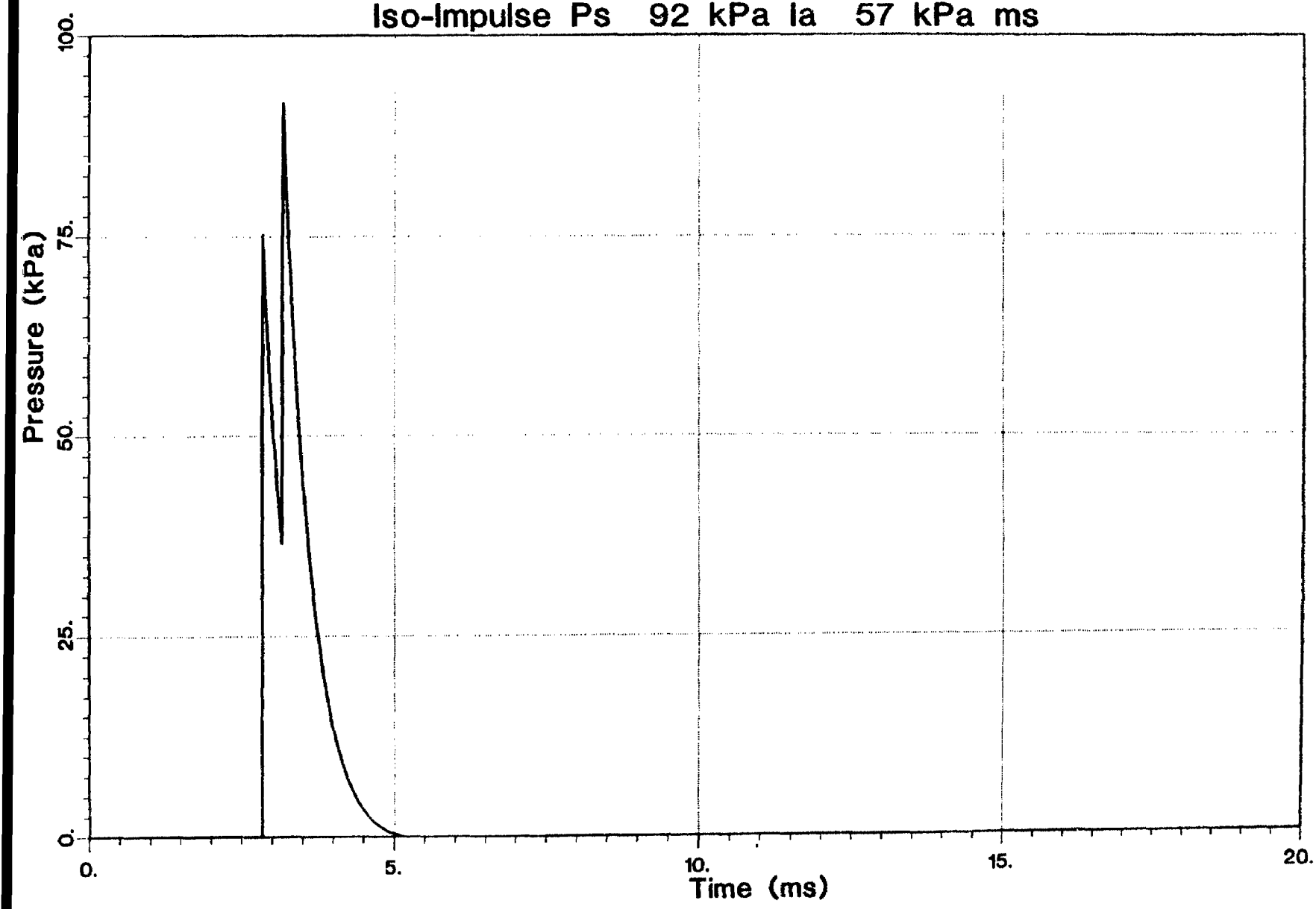
Maximum Pressure	92.0 kPa
Positive duration (Ta)	2.3 ms
Positive Impulse (Ia)	57.0 kPa ms
Total Impulse (It)	57.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO1 Iso-Impulse 92 kpa 57 kpa ms
07/26/88 Device 1 Channel 1 Shot 1
.454 kgmPENTO 0.457 m HOB, 2.29 m Range



Blast Overpressure Field Data
Case ISO3
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.914 m
Distance	1.7 m
Charge wt.	0.511 kgm
Charge type	Pentolite Sphere

Blast Parameters:

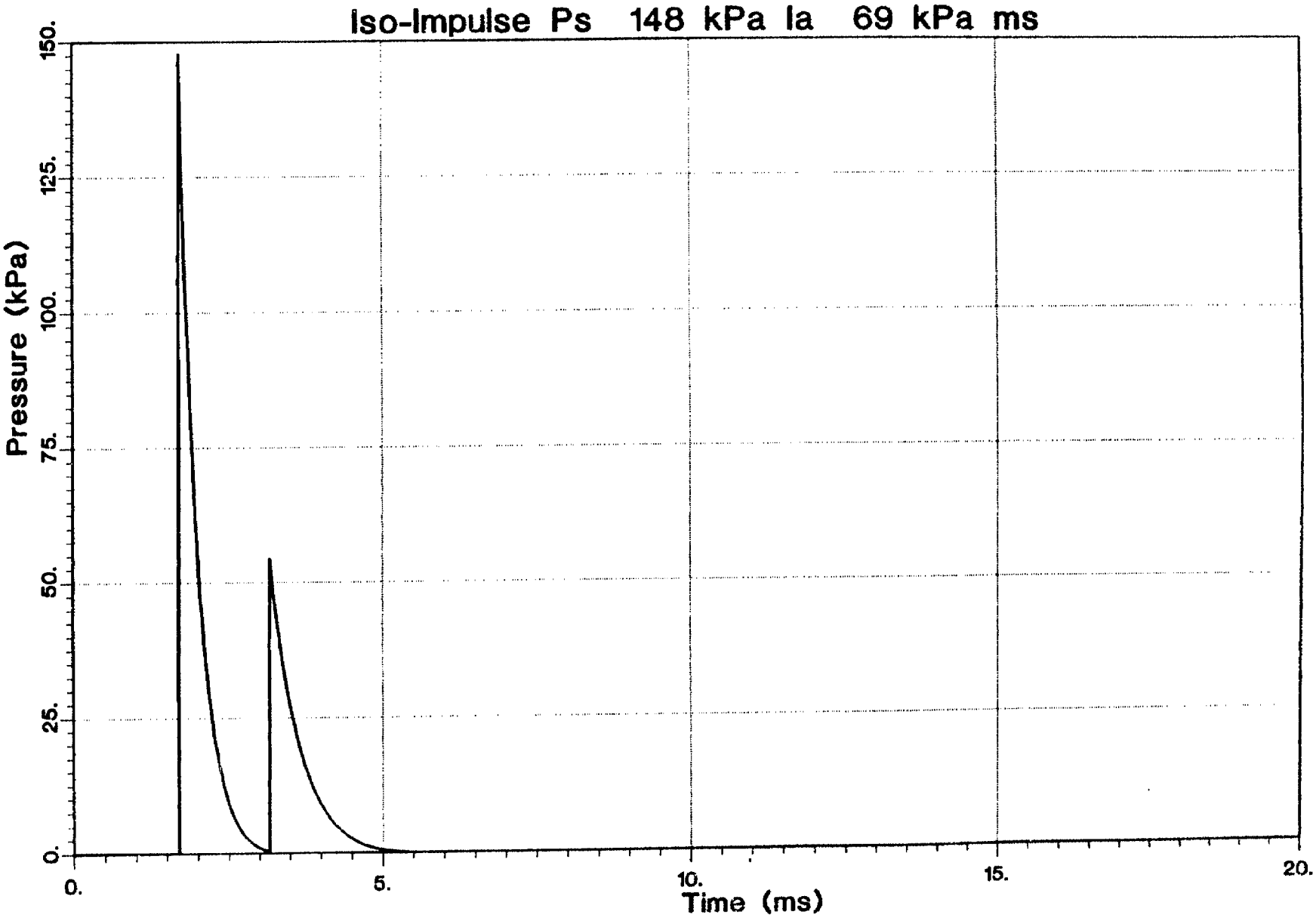
Maximum Pressure	148.0 kPa
Positive duration (Ta)	3.7 ms
Positive Impulse (Ia)	69.0 kPa ms
Total Impulse (It)	69.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade TH/N	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
				1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO3 Iso-Impulse 148 kpa 69 kpa ms
07/26/88 Device 1 Channel 1 Shot 2
.511 kgmPENTO 0.914 m HOB, 1.7 m Range



Blast Overpressure Field Data
Case ISO4
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.305 m
Distance	1.524 m
Charge wt.	0.454 kgm
Charge type	Pentolite Sphere

Blast Parameters:

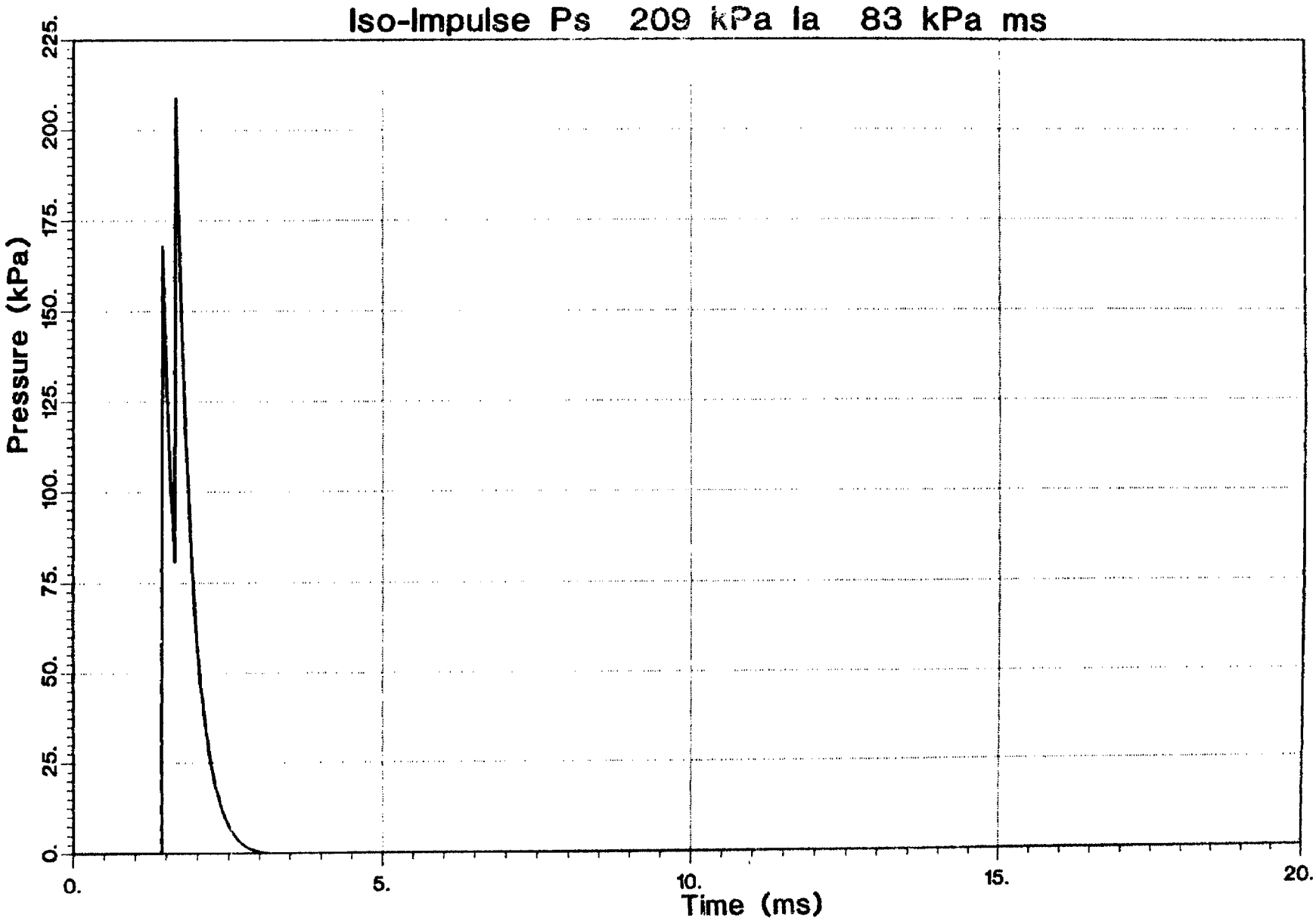
Maximum Pressure	209.1 kPa
Positive duration (Ta)	1.7 ms
Positive Impulse (Ia)	83.0 kPa ms
Total Impulse (It)	83.0 kPa ms

Shot:					Data Collection:					
Animal ID	Injury Grade M/N	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
				1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO4 Iso-Impulse 209 kpa 83 kpa ms
07/26/88 Device 1 Channel 1 Shot 3
.454 kgmPENTO 0.305 m HOB, 1.524 m Range



Blast Overpressure Field Data
Case ISO5
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.609 m
Distance	1.83 m
Charge wt.	1.362 kgm
Charge type	Pentolite Sphere

Blast Parameters:

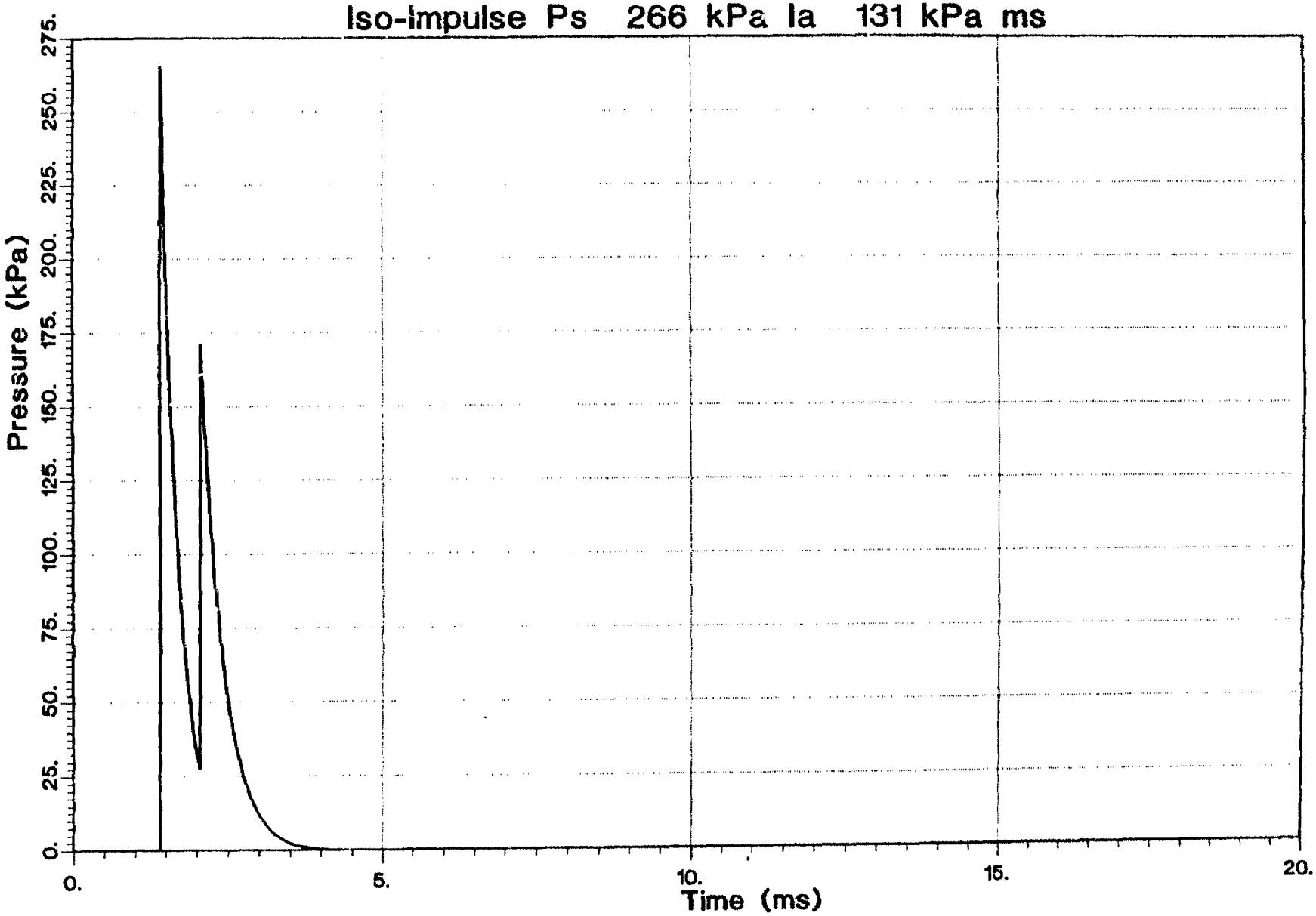
Maximum Pressure	266.0 kPa
Positive duration (Ta)	2.8 ms
Positive Impulse (Ia)	131.0 kPa ms
Total Impulse (It)	131.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	E			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO5 Iso-Impulse 266 kpa 131 kpa ms
07/26/88 Device 1 Channel 1 Shot 4
1.362 kgPENTO 0.609 m HOB, 1.83 m Range



Blast Overpressure Field Data
Case IS06
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.305 m
Distance	6.55 m
Charge wt.	11.35 kgm
Charge type	Pentolite Sphere

Blast Parameters:

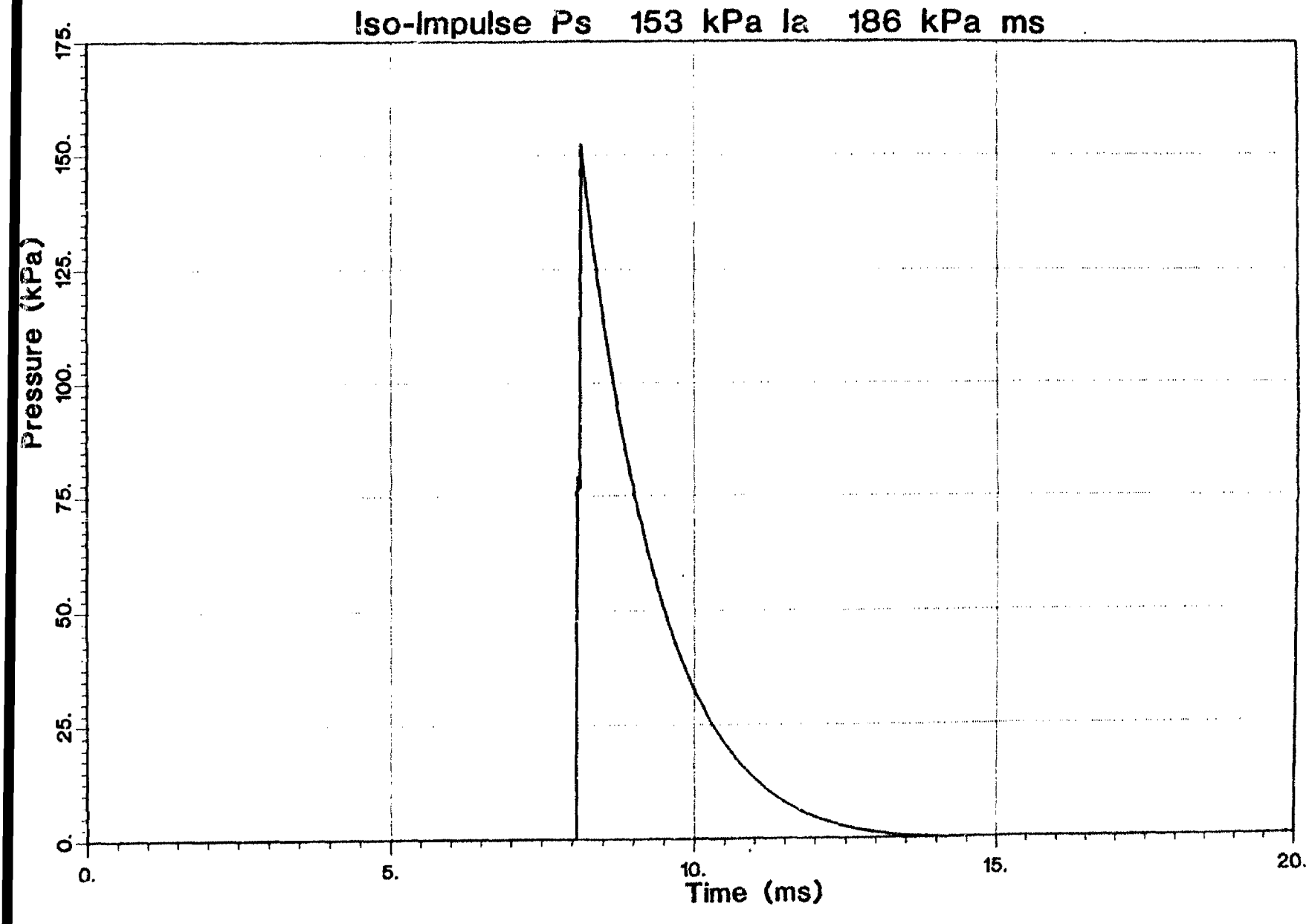
Maximum Pressure	153.0 kPa
Positive duration (Ta)	5.9 ms
Positive Impulse (Ia)	186.0 kPa ms
Total Impulse (It)	184.0 kPa ms

	Shot:				Data Collection:						
Animal ID	Injury Grade M/N	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
				1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO6 Iso-Impulse 153 kps 186 kpa ms
07/26/88 Device 1 Channel 1 Shot 5
11.35 kgPENTO 0.305 m HOB, 6.55 m Range



Blast Overpressure Field Data
Case ISO7
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.305 m
Distance	6.86 m
Charge wt.	10.0 kgm
Charge type	Pentolite Sphere

Blast Parameters:

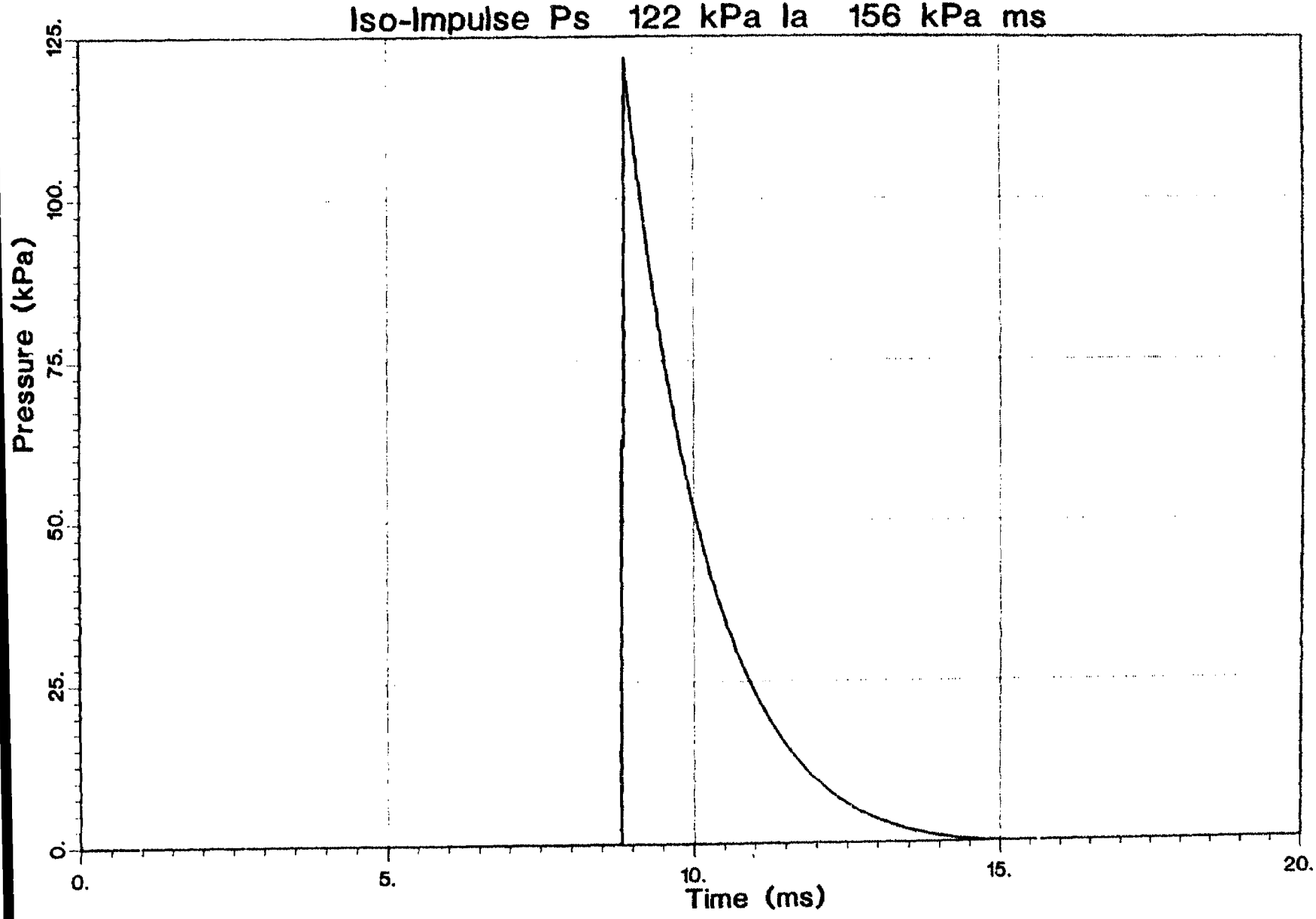
Maximum Pressure	122.0 kPa
Positive duration (Ta)	6.1 ms
Positive Impulse (Ia)	156.0 kPa ms
Total Impulse (It)	154.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade TH/N	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
				1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO7 Iso-Impulse 122 kpa 156 kpa ms
07/26/88 Device 1 Channel 1 Shot 6
10.0 kgmPENTO 0.305 m HOB, 6.86 m Range



Blast Overpressure Field Data
Case ISO8
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.914 m
Distance	7.62 m
Charge wt.	11.0 kgm
Charge type	Pentolite Sphere

Blast Parameters:

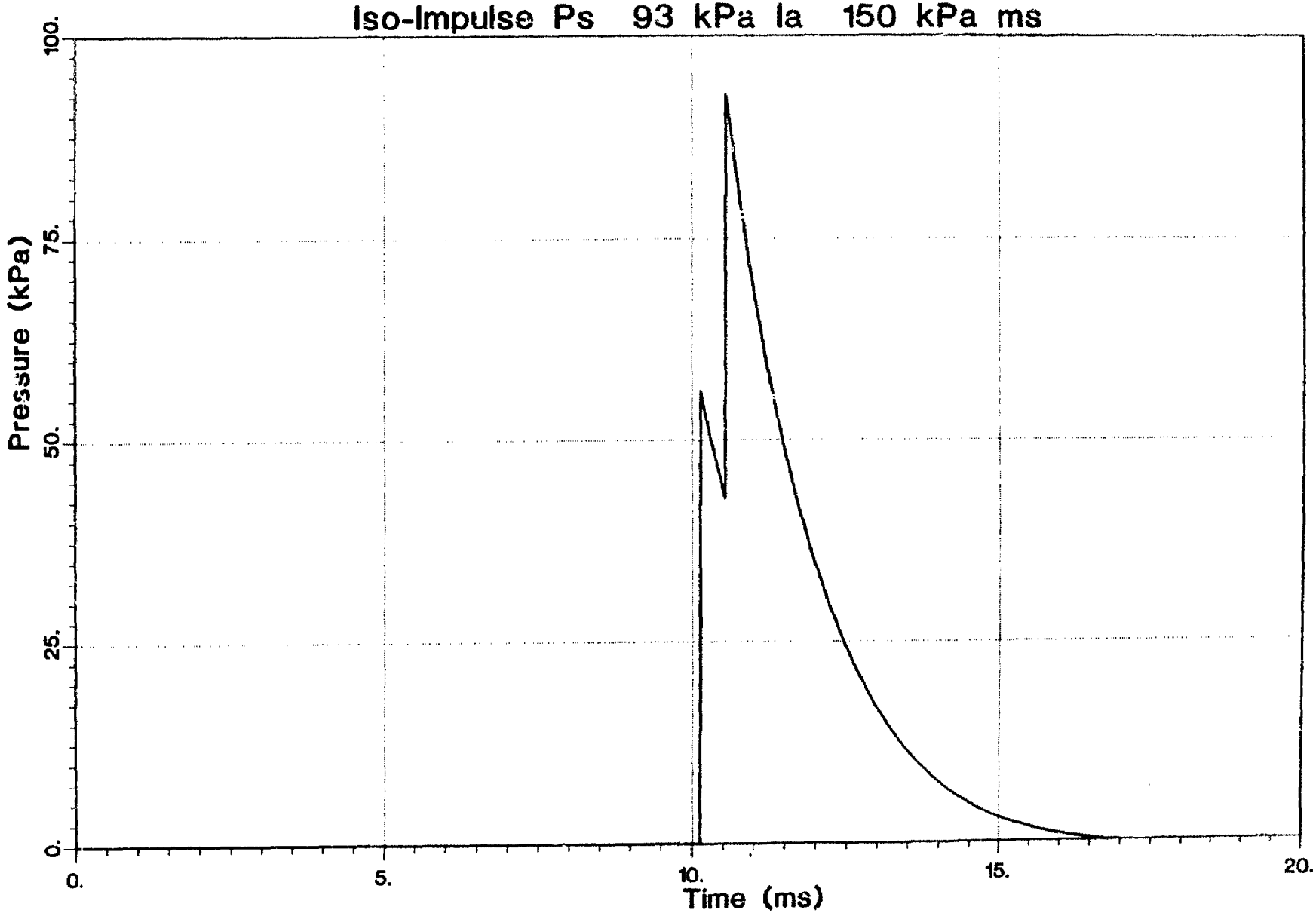
Maximum Pressure	93.0 kPa
Positive duration (Ta)	6.8 ms
Positive Impulse (Ia)	150.0 kPa ms
Total Impulse (It)	148.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO8 Iso-Impulse 93 kpa 150 kpa ms
07/2 /88 Device 1 Channel 1 Shot 7
11.0 kgmPENTO 0.914 m HOB, 7.62 m Range



Blast Overpressure Field Data
Case ISO9
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.914 m
Distance	10.0 m
Charge wt.	9.08 kgm
Charge type	Pentolite Sphere

Blast Parameters:

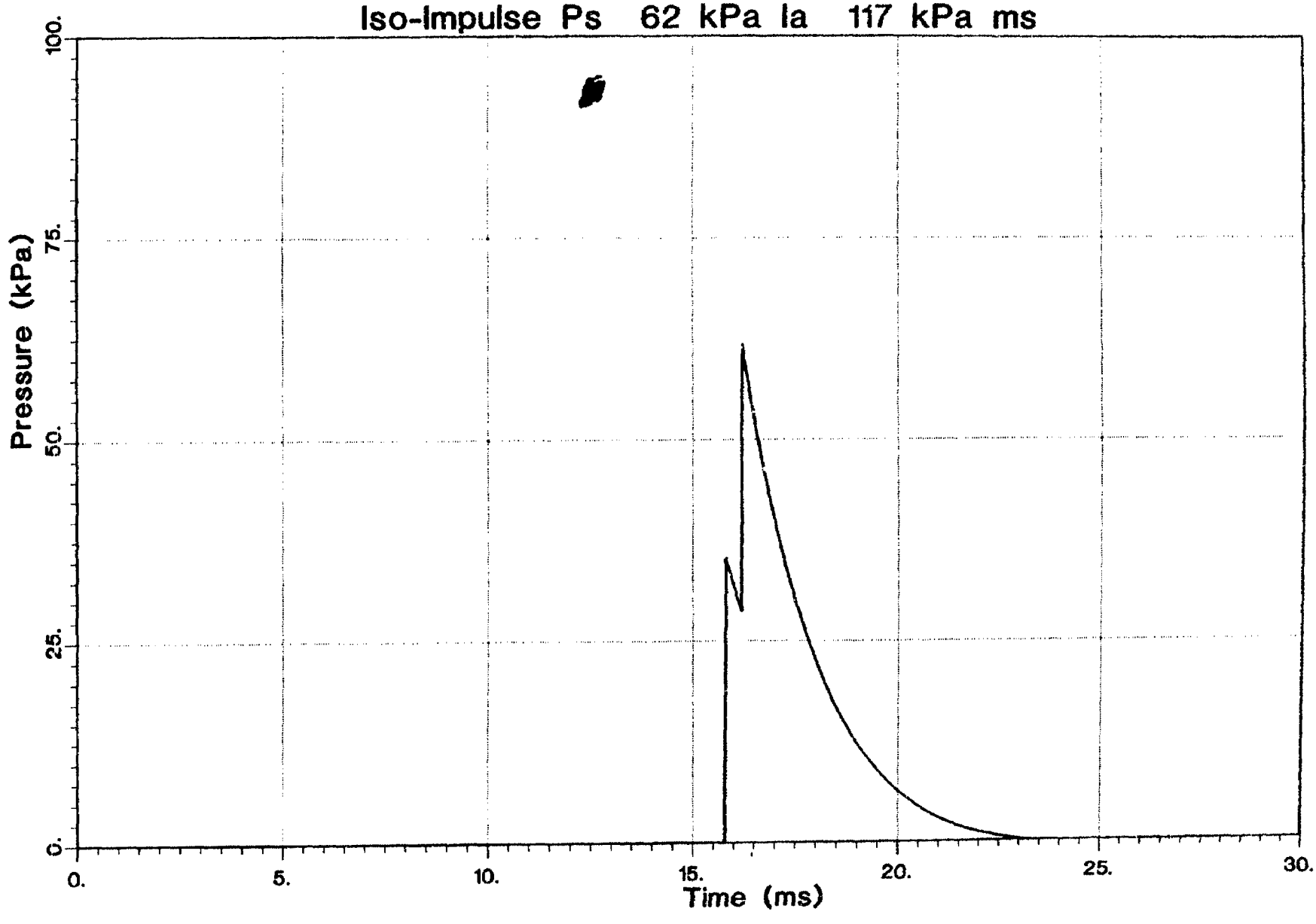
Maximum Pressure	62.0 kPa
Positive duration (Ta)	7.5 ms
Positive Impulse (Ia)	117.0 kPa ms
Total Impulse (It)	114.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO9 Iso-Impulse 62 kpa 117 kpa ms
07/26/88 Device 1 Channel 1 Shot 8
9.08 kgmPENTO 0.914 m HOB, 10.0 m Range



Blast Overpressure Field Data
Case ISO11
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.457 m
Distance	11.0 m
Charge wt.	15.0 kgm
Charge type	Pentolite Sphere

Blast Parameters:

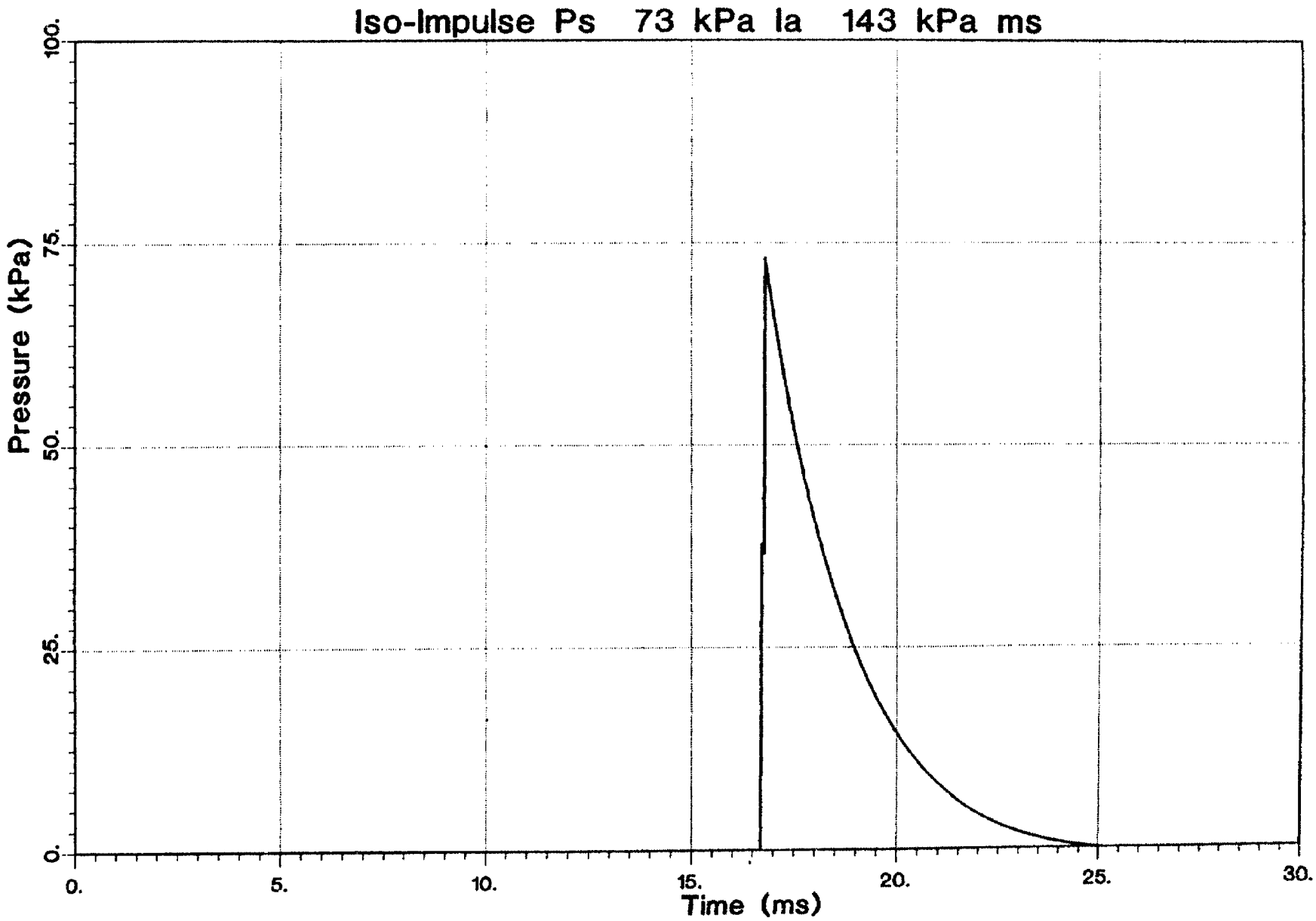
Maximum Pressure	73.0 kPa
Positive duration (Ta)	8.4 ms
Positive Impulse (Ia)	143.0 kPa ms
Total Impulse (It)	140.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO11 Iso-Impulse 73 kpa 143 kpa ms
07/26/88 Device 1 Channel 1 Shot 9
15.0 kgmPENTO 0.457 m HOB, 11.0 m Range



Blast Overpressure Field Data
Case ISO12
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.914 m
Distance	16.0 m
Charge wt.	24.0 kgm
Charge type	Pentolite Sphere

Blast Parameters:

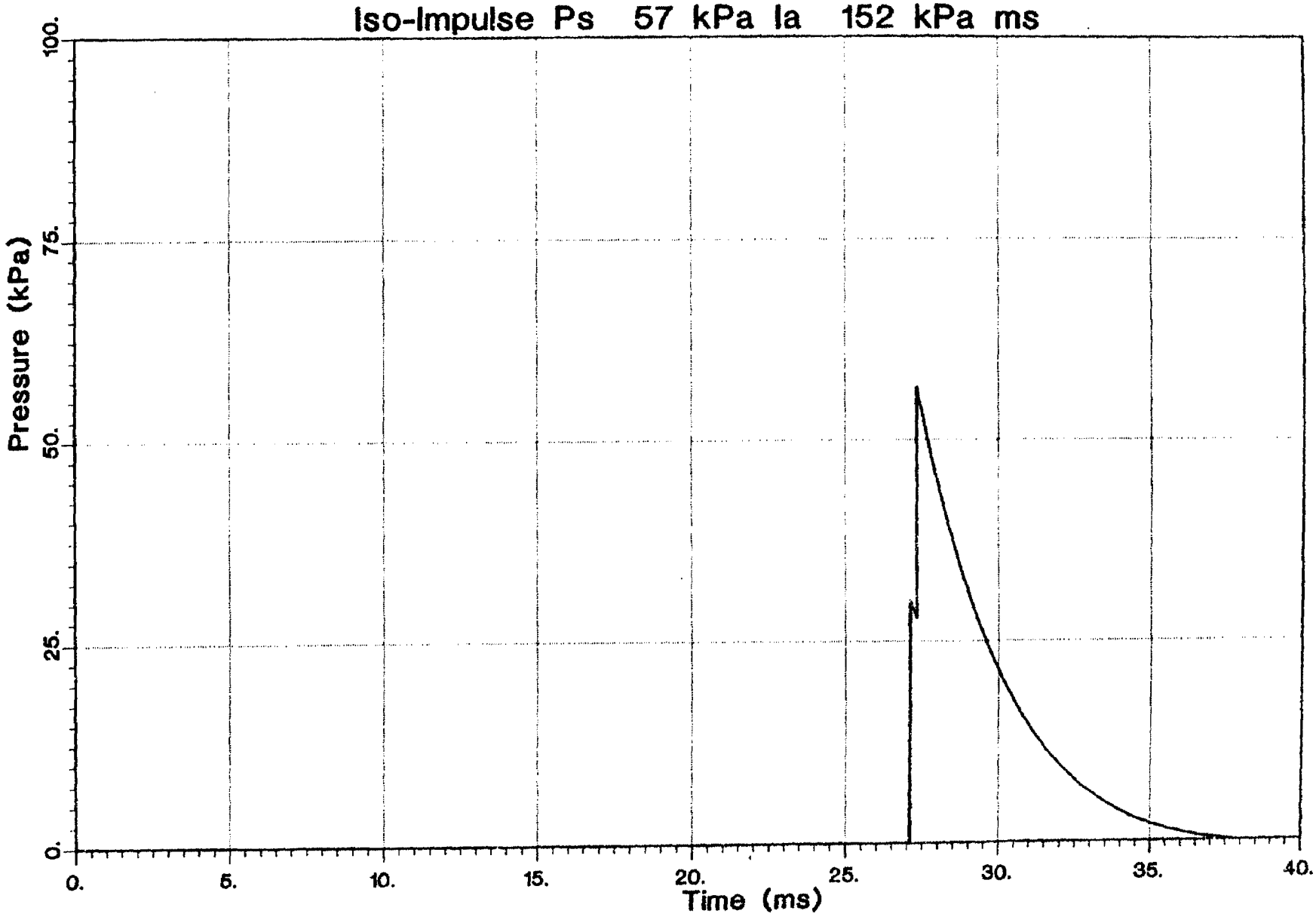
Maximum Pressure	57.0 kPa
Positive duration (Ta)	10.7 ms
Positive Impulse (Ia)	152.0 kPa ms
Total Impulse (It)	149.0 kPa ms

	Shot:				Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO12 Iso-Impulse 57 kpa 152 kpa ms
07/26/88 Device 1 Channel 1 Shot 10
24.0 kgmPENTO 0.914 m HOB, 16.0 m Range



Blast Overpressure Field Data
Case ISO13
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.457 m
Distance	14.5 m
Charge wt.	32.0 kgm
Charge type	Pentolite Sphere

Blast Parameters:

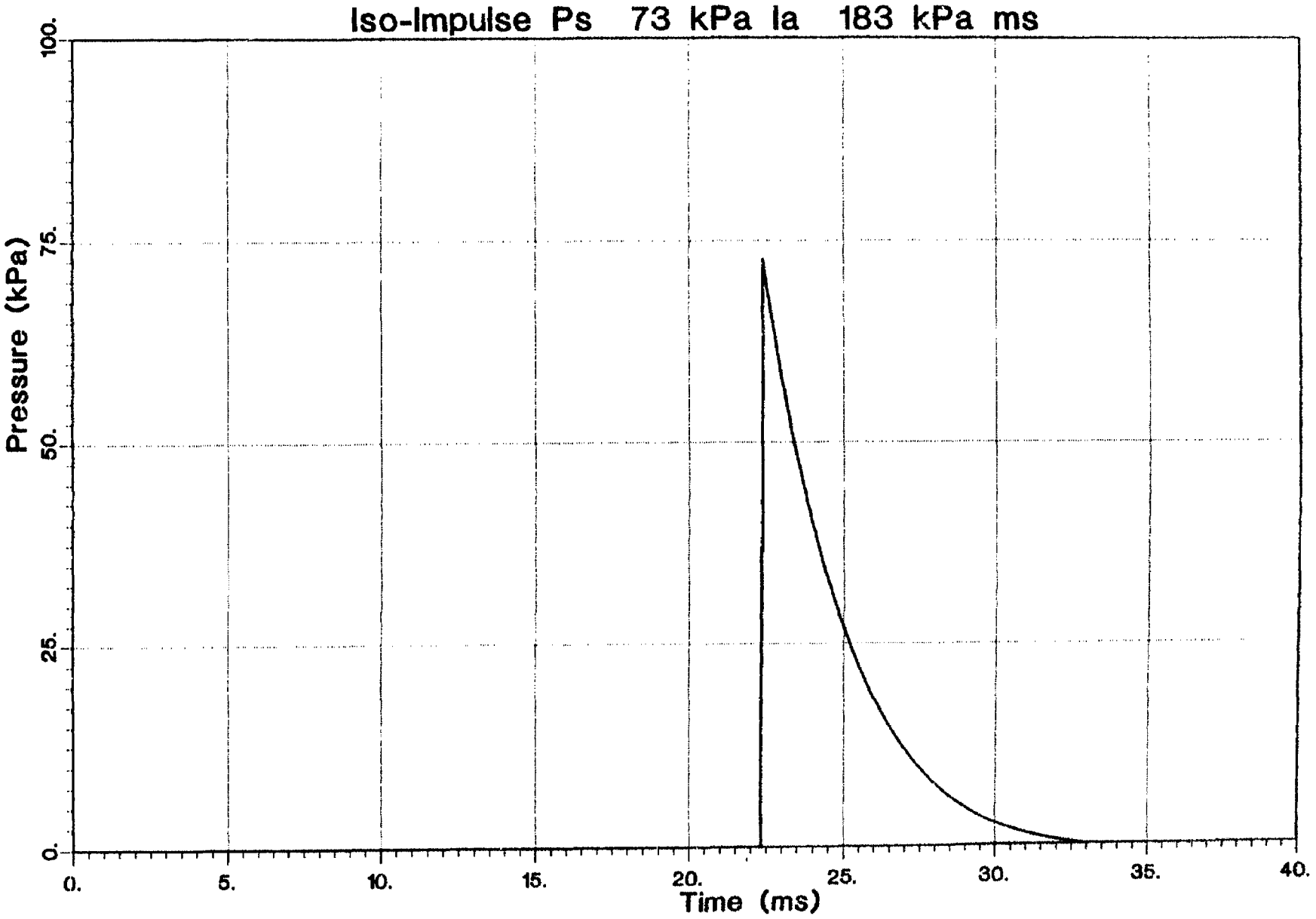
Maximum Pressure	73.0 kPa
Positive duration (Ta)	10.8 ms
Positive Impulse (Ia)	183.0 kPa ms
Total Impulse (It)	179.0 kPa ms

Shot:					Data Collection:
Animal ID	Injury Grade N	Time	Date	Ref #	Ps Skin Lamb Esoph Plral Adom Vic
				1	

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO13 Iso-Impulse 73 kpa 183 kpa ms
07/26/88 Device 1 Channel 1 Shot 11
32.o kgmPENTO 0.457 m HOB, 14.5 m Range



Blast Overpressure Field Data
Case ISO14
Location Albuquerque

Blast Conditions:

Geometry	Iso Impulse Free Field 20 Exposures
H.O.B.	0.914 m
Distance	18.0 m
Charge wt.	42.0 kgm
Charge type	Pentolite Sphere

Blast Parameters:

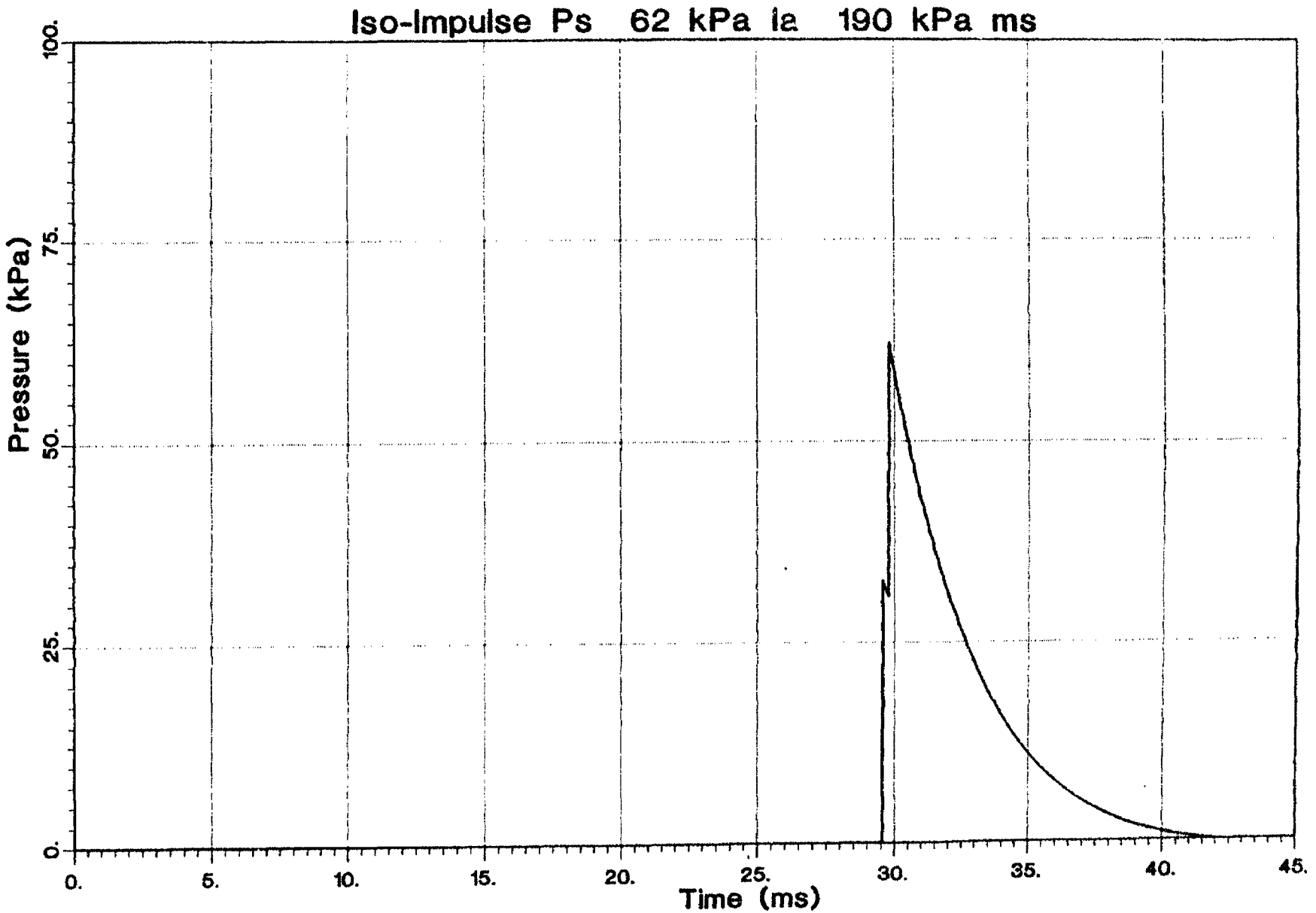
Maximum Pressure	62.0 kPa
Positive duration (Ta)	12.5 ms
Positive Impulse (Ia)	190.0 kPa ms
Total Impulse (It)	189.0 kPa ms

Shot:					Data Collection:						
Animal ID	Injury Grade	Time	Date	Ref #	Ps	Skin	Lamb	Esoph	Plral	Adom	Vic
	N			1							

Reference:

1) Presentation of Iso-Impulse Study (20 Blast).

ISO14 Iso-Impulse 62 kpa 190 kpa ms
07/26/88 Device 1 Channel 1 Shot 12
42.0 kgmPENTO 0.914 m HOB, 18.0 m Range



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